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Economic Impact Analysis of Effluent Limitations Guidelines and Standards for the Aluminum Forming Point Source Category

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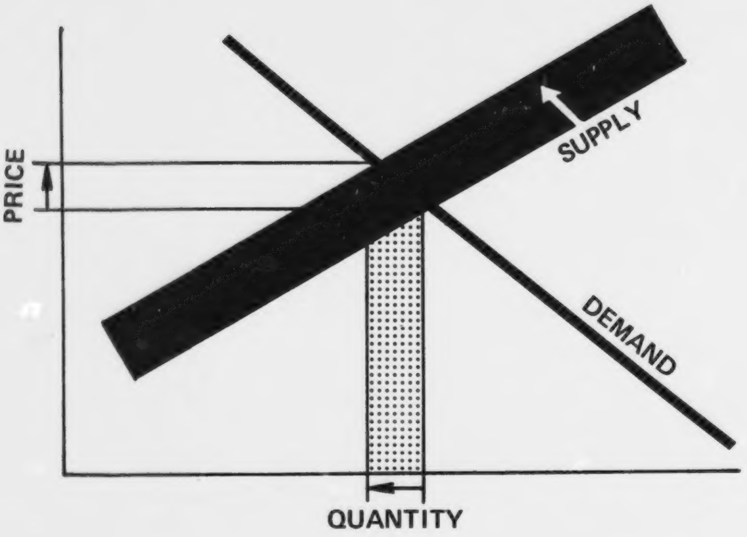

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The U.S. Environmental Protection Agency issued effluent guidelines and limitations for the Aluminum Forming Point Source Category in September, 1983. This report estimates the economic impact of pollution control costs in terms of price changes, production changes, effects on profitability, potential plant closures, unemployment, and other secondary effects. Impacts on new aluminum forming plants are also examined.

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Environmental Protection Agency
Office of Analysis and Evaluation
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SUMMARY

INTRODUCTION

Purpose

This report provides an identification and analysis of the economic impacts which are likely to result from the effluent limitations guidelines and standards on the aluminum forming category. These regulations include effluent limitations guidelines and standards based on Best Practicable Control Technology Currently Available (BPT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), and Pretreatment Standards for New and Existing Sources (PSNS and PSES, respectively) which are being promulgated under authority of Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 USC 1251 et seq., as amended by the Clean Water Act of 1977, P.L. 95-217), also called the "Act". The primary economic impact variables assessed in this study include the costs of the regulations and potential for these regulations to cause plant closures, price changes, unemployment, changes in industry profitability, structure and competition, shifts in the balance of foreign trade, industry growth, and impacts on small businesses.

Industry Coverage and Segmentation

The aluminum forming category, as defined in this study, includes the following six technical (or process) subcategories:

- Rolling with neat oils
- Rolling with emulsions
- Extrusion
- Forging

- Drawing with neat oils
- Drawing with emulsions or soaps.

For the purpose of assessing the economic impacts of the regulations, the aluminum forming industry is divided into the following seven major groups of plants:

- Sheet and plate plants
- Foil plants
- Tube and extruded shapes plants
- Forging plants
- Conductor wire and cable plants
- Sheet and plate; foil; and tube and extruded shapes plants
- Rod, bar, and bare wire; and conductor wire and cable plants.

This market-oriented segmentation was selected to facilitate consideration of product market characteristics and industry pricing behavior and, in turn, the likely price and output impacts of the regulations.

METHODOLOGY

The approach used to assess the economic impacts likely to occur as a result of the costs of each regulatory option is to (1) develop an operational description of the price and output behavior of the industry and (2) assess the likely plant-specific responses to the incurrence of the compliance costs enumerated in the body of this report. Thus, industry conditions before and after compliance with the regulations are compared. Supplemental analyses are used to assess linkages of the aluminum forming industry's conditions to other effects such as employment, community, and balance of trade impacts. These analyses were performed for three regulatory options considered by EPA. Specifically, the methodology can be divided into nine major steps. Although each step is described independently, there is considerable interdependence among them. The nine steps are described in the following paragraphs.

Step 1: Description of Industry Characteristics

The first step in the analysis is to develop a description of basic industry characteristics such as the determinants of demand, market structure, the degree of intra-industry competition, and financial performance. The resulting observations indicated the type of analysis needed for the industry. The sources for this information include government reports, trade association data, discussions with various trade associations and industry personnel, and an EPA survey of firms in the industry.

Step 2: Supply - Demand Analysis

The second step in the analysis is a determination of the likely changes in market prices and industry production levels resulting from each regulatory option. The estimates of post-compliance price and output levels are used in the plant-level analysis (Steps 4, 5, and 6) to determine post-compliance revenue and profit levels for specific plants in each group.

A pricing strategy that would maintain the industry-wide initial return on sales is assumed as an approximation of industry-wide price increases. The post-compliance market price levels are used, in a later step, to assess the financial condition of individual aluminum forming facilities.

Step 3: Compliance Cost Estimates

Investment and annual compliance costs for three treatment options were estimated by EPA for each aluminum forming establishment. These cost estimates form the basis for the economic impact analysis.

Step 4: Plant-Level Profitability Analysis

The basic measure of financial performance used to assess the impact of the regulations on the profitability of individual plants is return on investment (ROI). Plants with after-compliance ROI (before taxes) below a threshold value of 2.7 percent are considered potential plant closures. The 2.7 percent ROI threshold value corresponds to 8 percent after-tax return on liquidation value of equity (given a number of assumptions described in the report) which is assumed to be the minimum return for a business to continue operation (see Appendix B). Due to the unavailability of plant-specific baseline financial characteristics for the aluminum forming industry, average industry financial and operating ratios were applied to each plant.

Step 5: Capital Requirements Analysis

In addition to analyzing the potential for plant closures from a profitability perspective, it is also necessary to assess the ability of firms to make the initial capital investment needed to construct and install the required treatment systems. The analysis of capital availability was based on the "fixed charge coverage" ratio which is defined as the ratio of earnings before interest and taxes to interest payments. This ratio was calculated for each plant and compared to a threshold value to help determine the potential for significant plant-level impacts.

Step 6: Plant Closure Analysis

The decision to close a plant, like most major investment decisions, is largely based on financial performance, but is ultimately judgmental. This is because the decision involves a wide variety of considerations, many of which cannot be quantified or even identified. Assessments of the degree of impacts on individual plants were made by evaluating the above financial variables in conjunction with nonfinancial and nonquantifiable factors, such as substitutability of products, plant and firm integration, the existence of specialty markets, and expected market growth rates.

Step 7: Other Impacts

"Other impacts" which result from the assessment of basic price, production, and plant-level profitability changes, include impacts on employment, communities, industry structure, and balance of trade. These impacts are estimated via supplementary analyses that are explained where the results are reported in appropriate portions of the report.

Step 8: New Source Impacts

This step analyzes the effects of NSPS/PSNS guidelines upon new plant construction and substantial modification to existing facilities in the aluminum forming industry. The analysis is based on a comparison of the compliance costs of the new source treatment technologies to those of the selected BAT and PSES treatment options.

Step 9: Small Business Analysis

The Regulatory Flexibility Act requires Federal regulatory agencies to evaluate small entities throughout the regulatory process. This analysis identifies the economic impacts which are likely to result from the promulgation of the effluent regulations on small businesses in the aluminum forming industry. Most of the information and analytical techniques in the small business analysis are drawn from the general economic impact analysis. The specific conditions of small firms are evaluated against the background of general conditions in the aluminum forming markets.

For purposes of regulation development, a small business definition based on plant output volume was selected. The impacts on small plants were assessed by examining the distribution by plant size of the number of aluminum forming plants, plant revenues, compliance costs, and potential closures resulting from the regulations.

INDUSTRY CHARACTERISTICS

The EPA identified 279 aluminum forming plants in operation in 1977 (eight have since either shut down or discontinued their aluminum forming operations). Total employment of these 279 plants is approximately 31,200 people.

The U.S. aluminum forming industry is dominated by 12 integrated producers which accounted for 75 percent of total aluminum forming product shipments in 1980. The market shares of the integrated firms vary among the product groups studied from 85 percent for sheet and plate to 42 percent for tube and extruded products.

The major markets for aluminum forming products are the building and construction, transportation, and containers and packaging markets. The metallurgical properties of aluminum make its use more advantageous in many applications than other materials. Some of these properties are aluminum's light weight, high strength-to-weight ratio, high electrical conductivity, corrosion resistance, heat reflectivity, and easy maintenance.

The aluminum forming industry exhibits some characteristics of both competitive and noncompetitive markets. The evidences of noncompetitive market are generally inelastic demand, high industry concentration, high capital intensity, and instances of "price leadership." At the same time, there is also indication of competitive pricing situations such as the existence of relatively homogeneous products, relatively "normal" profit rates in the industry, and periodic oversupply resulting in price discounts.

BASELINE PROJECTIONS

Conditions in the aluminum forming industry to 1990, under the assumption that there would be no water pollution control requirements, are projected and summarized below:

- Industry demand for aluminum forming products will grow moderately
- The number of establishments will not change significantly during the 1980's and there will be no baseline closures
- Industry profitability will remain consistent with historical patterns.

COST OF COMPLIANCE

Based on the analysis of the potential pollutant parameters and treatment in place in the aluminum forming industry, EPA identified 6 treatment technologies that are most applicable for the reduction of the selected pollutants. These treatment technologies are described in detail in the Development Document and are listed below:

- Treatment Option 1: Hexavalent chromium reduction, cyanide removal and chemical emulsion breaking (where applicable); oil skimming; chemical precipitation; sedimentation
- Treatment Option 2: Option 1 plus flow reduction by recycle, and counter-current rinsing
- Treatment Option 3: Option 2 plus polishing filtration after settling
- Treatment Option 4: Option 2 plus thermal emulsion breaking to achieve zero discharge of emulsified lubricants

- Treatment Option 5: Option 4 plus polishing filtration
- Treatment Option 6: Option 5 plus granular activated carbon as a preliminary treatment step.

EPA's evaluation of Treatment Option 6 concluded that this technology would provide only minimal incremental removal of pollutants at significantly higher costs than the other options. For this reason, Treatment Option 6 was eliminated from consideration. Furthermore, Treatment Options 4 and 5 are not being considered for promulgation. Consequently, the economic impact analysis concentrated on Treatment Options 1, 2, and 3 only.

Tables S-1 and S-2 present the estimated investment and annual compliance costs for the existing sources in 1978 and 1982 dollars, respectively.

FINDINGS

Plant Closure Impact

No plant closures are projected for the sheet, foil, or rod and bar product groups. Of the 82 discharging tube and extruded shapes plants, three plant closures are projected at Treatment Options 1, 2 and 3. In addition, one wire drawing plant and one forging plant are considered potential closures at all three treatment options. The plant closure findings are summarized in Table S-3.

Employment, Community, and Regional Effects

As shown in Table S-3, there is potential for 5 plant closures involving a loss of about 300 jobs. None of these plants account for a significant portion of community employment, hence the community and regional impacts seem to be insignificant.

TABLE S-1
TOTAL COSTS BY INDUSTRY SEGMENT, ALUMINUM FORMING INDUSTRY
(1978 dollars)

Industry Segment	Number of Plants	Total Production	Value of Shipments	Option 1		Option 2		Option 3	
				Annual Cost	Capital Investment	Annual Cost	Capital Investment	Annual Cost	Capital Investment
		mil lbs	$mil	-----------	-----------	$ Thousands	-----------	-----------	-----------
Sheet, Strip & Plate	21	3,080	2,970	3,816	6,651	6,028	13,015	7,008	16,543
Foil	6	179	203	0	0	0	0	0	0
Tube and Extruded Shapes	158	2,259	2,198	13,390	20,464	14,911	23,287	15,761	25,727
Wire	44	377	408	750	1,385	750	1,385	792	1,528
SFE a/	20	3,511	2,963	5,365	8,885	5,470	9,132	5,948	10,537
RBW b/	6	485	588	2,024	4,160	2,024	4,160	2,122	4,549
Forging	16	99	282	2,043	4,322	2,106	4,543	2,218	4,962
Total	271	9,990	9,612	27,388	45,867	31,289	55,522	33,849	63,846

a/ Sheet, Strip & Plate; Foil; Tube and Extruded Shapes

b/ Rod, Bar, & Bare Wire; Conductor Wire and Cable

Source: JRB Associates estimates.

TABLE S-2
TOTAL COSTS BY INDUSTRY SEGMENT, ALUMINUM FORMING INDUSTRY
(1982 dollars)

Industry Segment	Number of Plants	Total Production	Value of Shipments	Option 1 Annual Cost	Option 1 Capital Investment	Option 2 Annual Cost	Option 2 Capital Investment	Option 3 Annual Cost	Option 3 Investment
		mil lbs	$mil	---------- $ Thousands ----------					
Sheet, Strip & Plate	21	3,080	2,970	5,113	8,912	8,078	17,440	9,391	22,168
Foil	6	179	203	0	0	0	0	0	0
Tube and Extruded Shapes	158	2,259	2,198	17,943	27,422	19,981	31,205	21,120	34,474
Wire	44	377	408	1,005	1,856	1,005	1,856	1,061	2,048
SFE a/	20	3,511	2,963	7,189	11,906	7,330	12,237	7,970	14,120
RBW b/	6	485	588	2,712	5,574	2,712	5,574	2,843	6,096
Forging	16	99	282	2,738	5,791	2,822	6,088	2,972	6,649
Total	271	9,990	9,612	36,700	61,462	41,927	74,399	45,358	85,554

a/ Sheet, Strip & Plate; Foil; Tube and Extruded Shapes

b/ Rod, Bar, & Bar Wire; Conductor Wire and Cable

Source: JRB Associates estimates.

TABLE S-3. SUMMARY OF PLANT CLOSURE ANALYSIS
(ALL TREATMENT OPTIONS)

		Discharging Plants	
	Total	Direct	Indirect
Tube and Extruded Shapes			
Number of Plants	82	36	46
Number of Closures	3	2	1
Employment Losses	258	221	37
Annual Production of Closed Facilities (million lbs)	26	13	13
Market Share of Closed Facilities (%)	1.2	0.6	0.6
Conductor Wire and Cable			
Number of Plants	9	1	8
Number of Closures[a/]	1	0	1
Employment Losses	203	0	203
Annual Production of Closed Facilities (million lbs)	6	0	6
Market Share of Closed Facilities (%)	1.0	0	1.0
Forging			
Number of Plants	12	0	12
Number of Closures[a/]	1	0	1
Employment Losses	36	0	36
Annual Production of Closed Facilities (million lbs)	<1	0	<1
Market Share of Closed Facilities (%)	<0.1	0	<0.1

[a/] These projected closures are line closures; the plants also manufacture other products in addition to aluminum forming products.

Source: JRB Associates estimates.

Substitution Effects

The effects of the regulations on substitution potential are insignificant, since the price increases associated with the compliance costs and the corresponding quantity reductions are small.

Foreign Trade Impacts

Since the price increases estimated to result from the regulations are small, such price increases would not alter the trading pattern substantially.

Industry Structure Effects

The impact of the regulations on the industry structure is negligible since only a small proportion of industry output is accounted for by the plants projected to close.

New Source Impacts

The treatment technology options for new sources are identical to the treatment options for existing sources. The selected treatment technology for existing sources is Technology Option 2. The selected NSPS and PSNS technology is Option 2 plus filtration (this is equivalent to existing source Technology Option 3). It is anticipated that the new source regulations would not constitute a significant hindrance to the addition of new capacity to the industry.

Impact on Small Entities

The regulations seem to have most impact on small aluminum wiredrawing and forging facilities; one wire plant with annual production less than 6 million pounds and one forging plant with less than 500,000 pounds of production are projected to close at all treatment options. Meanwhile, larger extrusion plants are also impacted by the regulations as two of the three projected closures have annual production between 10-15 million pounds.

1. INTRODUCTION

1.1 PURPOSE

This report identifies and analyzes the economic impacts which are likely to result from the effluent limitations guidelines and standards on the aluminum forming category. These regulations include effluent limitations and standards based on Best Practicable Control Technology Currently Available (BPT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), and Pretreatment Standards for New and Existing Sources (PSNS and PSES, respectively) which are being promulgated under authority of Section 301, 304, 306, 307, 308, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 USC1251 et seq., as amended by the Clean Water Act of 1977, P.L. 95-217), also called the "Act". The primary economic impact variables assessed in this study include the costs of the regulations and potential for these regulations to cause plant closures, price changes, unemployment, changes in industry profitability, structure and competition, shifts in the balance of foreign trade, and impacts on small businesses.

1.2 INDUSTRY COVERAGE

The aluminum forming category examined in this study is defined as those manufacturing activities classified under the following SIC groups:

- SIC 3353 - Aluminum Sheet, Plate, and Foil
- SIC 3354 - Aluminum Extruded Products
- SIC 3355 - Aluminum Rolling and Drawing, not elsewhere classified
- SIC 3357 - Nonferrous Wiredrawing and Insulating. (This category includes all nonferrous wire and cable manufacturers, but only plants drawing aluminum wire are examined in this study.)
- SIC 3463 - Nonferrous Forgings. (Only aluminum forging, SIC 34631, is examined in this study).

1.3 INDUSTRY SEGMENTATION

For the purpose of developing effluent limitations guidelines and standards, EPA designated the following six technical (or process) subcategories in the aluminum forming category:

- Rolling with neat oils
- Rolling with emulsions
- Extrusion
- Forging
- Drawing with neat oils
- Drawing with emulsions or soaps.

While this subcategorization scheme may be appropriate from a technical viewpoint, it is expected that the economic impacts of the regulations will vary with the type of aluminum forming product. The major types of aluminum forming products are:

- Sheet and plate
- Foil
- Tube and extruded shapes
- Forging
- Rod, bar and bare wire
- Conductor wire and cable.

Figure 1-1 shows the relationships of the SIC groups included in this study and the six major aluminum forming product groups above.

The plants in the industry are generally, but not always, specialized in one of the above mentioned product groups. Survey data collected by EPA indicate that 26 plants manufacture more than one type of product. Of these, 16 produce sheet, plate, and foil, 6 produce sheet, plate, tube and extruded shapes and 6 produce rod, bar and bare wire, and conductor wire and cable. Because compliance costs for these plants were estimated for the total plant and there is insufficient information to allocate these costs to each individual product, the analysis of economic impacts on these 26 plants

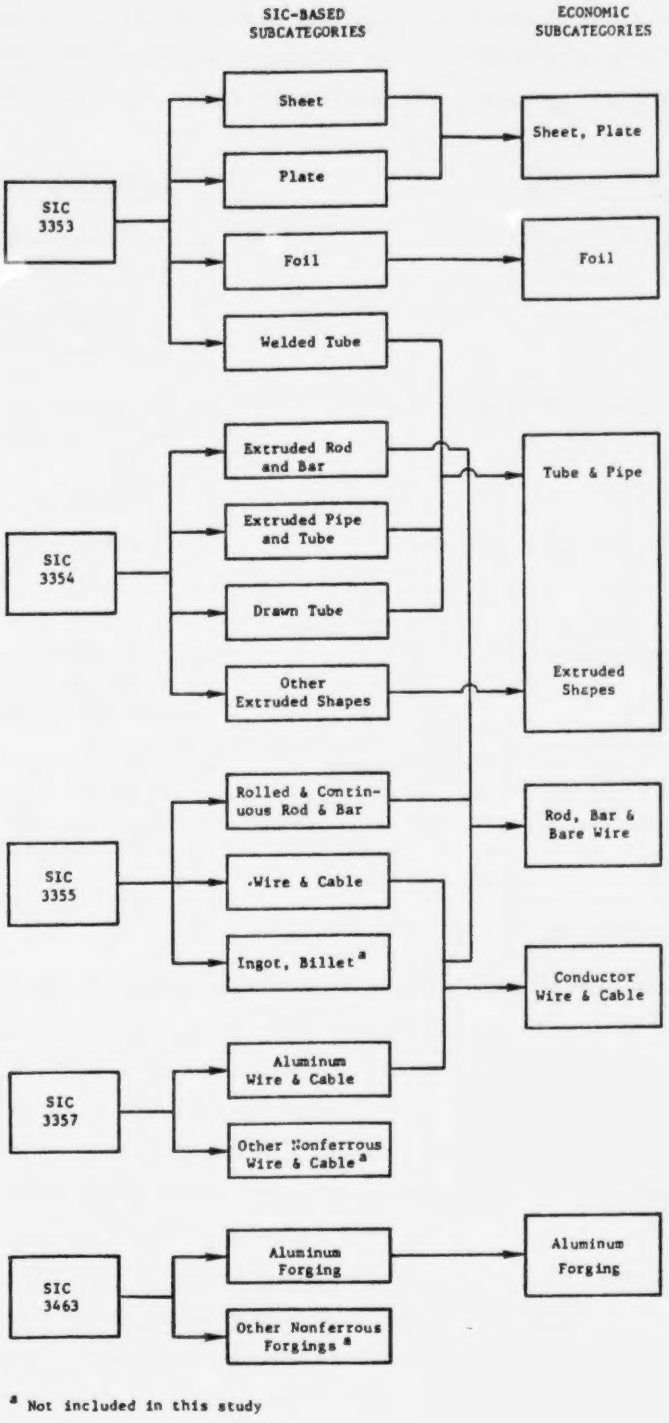
SIC-BASED SUBCATEGORIES
ECONOMIC SUBCATEGORIES
SIC 3353
Sheet
Plate
Foil
Welded Tube
Sheet, Plate
Foil
SIC 3354
Extruded Rod and Bar
Extruded Pipe and Tube
Drawn Tube
Other Extruded Shapes
Tube & Pipe
Extruded Shapes
SIC 3355
Rolled & Continuous Rod & Bar
Wire & Cable
Ingot, Billet[a]
Rod, Bar & Bare Wire
Conductor Wire & Cable
SIC 3357
Aluminum Wire & Cable
Other Nonferrous Wire & Cable[a]
SIC 3463
Aluminum Forging
Other Nonferrous Forgings[a]
Aluminum Forging
[a] Not included in this study

FIGURE 1-1. RELATIONSHIP BETWEEN SIC-BASED SUBCATEGORIES AND ECONOMIC SUBCATEGORIES OF THE ALUMINUM FORMING INDUSTRY

required the establishment of separate segments for multi-product plants. For this reason, the aluminum forming industry is organized into the following seven segments to represent the different types of plants in the industry:

Product Groups	Technical Subcategories
Sheet and plate	Rolling with neat oils; rolling with emulsions
Foil	Rolling with neat oils; rolling with emulsions
Tube and extruded shapes	Extrusion; drawing with neat oils; drawing with emulsions
Forging	Forging
Conductor wire and cable	Drawing with neat oils; drawing with emulsions
Sheet and plate; foil; and tube and extruded shapes	Rolling with neat oils; rolling with emulsions; extrusion; drawing with neat oils; drawing with emulsions
Rod, bar, and bare wire; and conductor wire and cable	Rolling with neat oils; rolling with emulsions; extrusion; drawing with neat oils; drawing with emulsions.

1.4 ORGANIZATION OF REPORT

The remainder of this report consists of seven chapters. Chapter 2 describes the analytical methodology employed, Chapter 3 provides the basic industry characteristics of interest, and Chapter 4 projects some of these key characteristics to the 1985 - 1990 time period, when the primary economic impacts of the regulations will be felt. Chapter 5 describes the pollution control technologies considered by EPA and their associated costs. The information in Chapter 5 is derived primarily from the companion technical study and is published in the *Development Document for Effluent Limitations Guidelines and Standards for the Aluminum Forming Point Source Category* (September 1983) prepared by EPA's Effluent Guidelines Division. Chapter 6 describes the economic impacts projected to result from the cost estimates presented in Chapter 5. Chapter 7 presents an analysis of the effects of the regulations on small business and Chapter 8 outlines the major limitations of the analysis and discusses the possible effects of the limitations on the major study conclusions.

2. STUDY METHODOLOGY

2.1 OVERVIEW

Figure 2-1 shows an overview of the analytical approach used to assess the economic impacts likely to occur as a result of the costs of each regulatory option. For the aluminum forming category, six regulatory options were considered; however, based on the high costs and the low pollutant removals, one of the options is excluded from further evaluation. The approach used in this study is to (1) develop an operational description of the price and output behavior of the industry, and (2) assess the likely plant-specific responses resulting from the compliance costs estimated for each regulatory option in Chapter 5.

The operational description of the price and output behavior is used, in conjunction with compliance costs estimated by EPA, to determine post-compliance industry price and production levels for each regulatory option and for each of the aluminum forming product groups. Each plant is then subjected to a financial analysis that uses capital budgeting techniques to determine potential closures. If necessary, the industry description is then revised, for each regulatory option, to incorporate the reduced supply into the analysis. Finally, other effects that flow from the basic price, production, and industry structure changes are determined. These include employment, community, and foreign trade impacts. Specifically, the study proceeded in the following nine steps:

1. Description of industry characteristics
2. Industry supply and demand analysis
3. Analysis of cost of compliance estimates
4. Plant level profitability analysis
5. Plant level capital requirements analysis
6. Assessment of plant closure potential
7. Assessment of other impacts
8. New source impacts
9. Small business analysis.

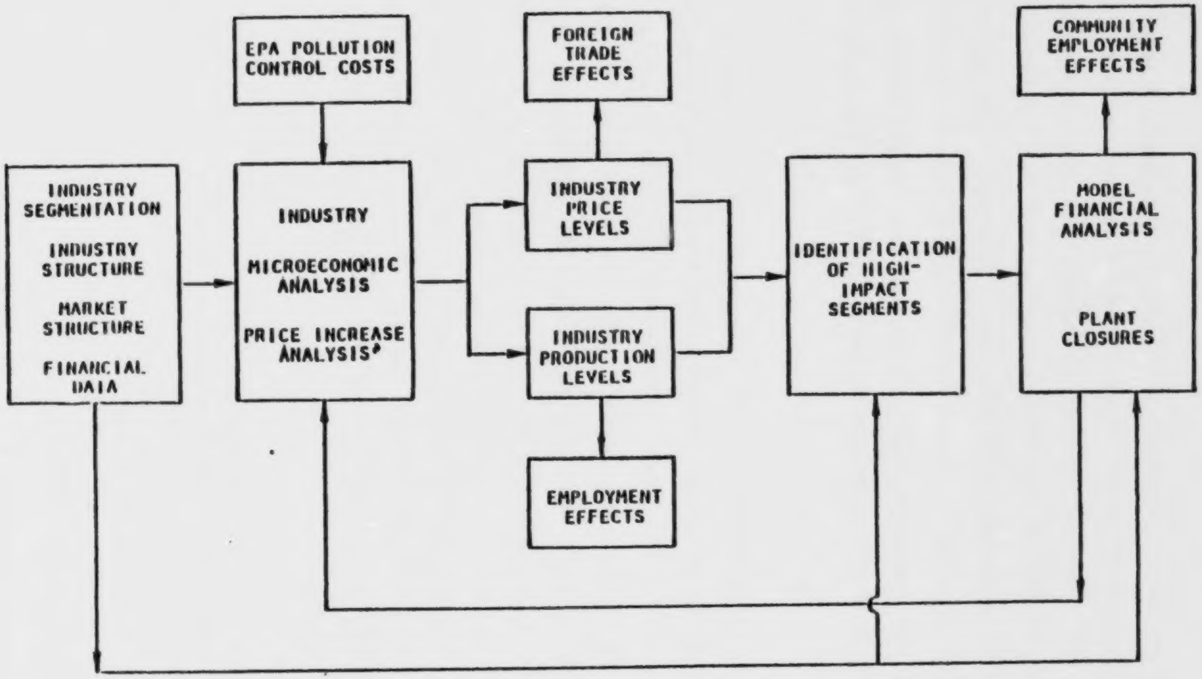
INDUSTRY SEGMENTATION
INDUSTRY STRUCTURE
MARKET STRUCTURE
FINANCIAL DATA
EPA POLLUTION CONTROL COSTS
INDUSTRY
MICROECONOMIC ANALYSIS
PRICE INCREASE ANALYSIS*
FOREIGN TRADE EFFECTS
INDUSTRY PRICE LEVELS
INDUSTRY PRODUCTION LEVELS
EMPLOYMENT EFFECTS
IDENTIFICATION OF HIGH-IMPACT SEGMENTS
COMMUNITY EMPLOYMENT EFFECTS
MODEL FINANCIAL ANALYSIS
PLANT CLOSURES

FIGURE 2-1 ECONOMIC ANALYSIS STUDY OVERVIEW

Although each of these steps is described separately in this section, it is important to realize that there are significant interactions between them, as shown in Figure 2-1.

The major sources of data used in this study are listed below.

- U.S. Environmental Protection Agency: EPA industry survey conducted in 1978 under Section 308 (of particular importance for this study are data on plant production volume and value of shipments); EPA estimates of compliance costs; and the Development Document.
- U.S. Department of Commerce: 1977 Census of Manufactures; Current Industrial Reports - Aluminum Ingot and Mill Products (1978-1982).
- U.S. Bureau of Mines: Mineral Commodity Profiles - Aluminum (1978).
- Federal Trade Commission: Quarterly Financial Report for Manufacturing, Mining and Trade Corporations (1978-1982); Annual Line of Business Report (1974-1976).
- U.S. Department of Labor: Producer Prices and Price Indexes (1978-1982).
- Council on Wage and Price Stability: Aluminum Prices 1974-1975, September 1976.
- Trade publications such as American Metal Market, Aluminum Statistical Review, Metal Statistics and Modern Metals (various issues, 1978-1982).
- Interviews with industry representatives.
- Corporate annual reports (1978-1982).

2.2 STEP 1: DESCRIPTION OF INDUSTRY CHARACTERISTICS

The first step in this analysis is to describe the basic industry characteristics. These characteristics, which include the determinants of demand, market structure, the degree of intra-industry competition, and financial performance, are described in Chapter 3 of this report. The sources for this information include those listed above, such as government reports, trade association data, discussions with various trade association representatives and individuals associated with the industry.

2.3 STEP 2: SUPPLY-DEMAND ANALYSIS

The purpose of the supply-demand analysis, step 2 of the study approach, is to determine the likely changes in market prices and industry production levels resulting from each regulatory option. The estimates of post-compliance price and output levels are used in the plant-level analysis to determine post-compliance revenue and profit levels for specific plants in each product group. If prices are raised without significantly reducing product demand and companies are able to maintain their current financial status, the potential for plant closings will be minimal. If prices cannot be raised to fully recover compliance costs because of the potential for a significant decline in product demand or because of significant intra-industry competition, the firms may attempt to maintain their financial status by closing higher-cost/less-efficient plants. The supply-demand analysis was divided into four basic components: determination of industry structure, projection of possible changes in industry structure during the 1980's, determination of plant- and firm-specific operational parameters (e.g., production costs, profit rates, etc.), and development of price-quantity algorithms.

Short-run pricing behavior depends upon the market structure of the industry, which can range from competitive to monopolistic competition, to oligopoly and to monopoly situations. Many economic impact studies begin by assuming perfect competition. However, as described in Chapter 3 the product groups covered in this study exhibit some characteristics that are indicative of imperfectly-competitive pricing mechanisms.

The perfectly competitive market structure is one in which there are many buyers and sellers and the actions of any one of these do not significantly affect the market. Firms in a competitive market generally earn a "normal" rate of return on their assets and any industry-wide cost increase will require the firms to raise prices to maintain profitability. The extent of the price increases is determined by the interaction of the elasticities of supply and demand. That is, the amount of the cost increase that will be passed through into higher prices is:

$$\frac{E_s}{E_d + E_s} \qquad \text{(Equation 1)}$$

where E_s is the elasticity of supply and E_d is the elasticity of demand.[1/]

The oligopolistic pricing scheme is applicable for those product categories which exhibit the following market characteristics:

- Few firms in the product group
- High industry concentration
- Low degree of foreign competition
- Abnormally high profitability
- Low demand elasticities
- Highly capital-intensive
- Large degree of integration of production, marketing, and distribution
- Large degree of specialized knowledge.

Industries which exhibit the first three of these characteristics are those in which the pricing and output actions of one firm will directly affect those of other firms in the industry. While these conditions do not guarantee oligopolistic behavior, they are necessary conditions and good indicators that oligopolistic behavior exists. Abnormally high profits in an industry would, in time, tend to attract new entrants to the industry, thereby increasing price competition (because there are more competitors) and industry marginal cost (to the extent that new entrants have higher costs). However, very high profits over long periods of time which are not explained by such factors as excess risk, unusual amounts of technological innovation, or firm size may be an indicator that an imperfectly competitive market structure exists. Such conditions may occur when entry into an industry is difficult. The last three of the above points are indicators of difficulty of entry into the market.

[1/] Levenson, Albert M., and Solon, B.S., Outline of Price Theory, Holt, Rinehart and Winston, Inc., 1964, pp. 56-59.

As described in Chapter 3, the domestic aluminum forming industry exhibits some characteristics of non-competitive markets such as high concentration ratios, high capital intensity, and high integration. On the other hand, the industry also exhibits some characteristics that are indicative of competitive markets such as generally "normal" profitability and periodic oversupply resulting from cyclical fluctuations in the economy. Because of the conflicting information regarding the industry's market structure, no single conclusion is drawn regarding an underlying principle or model which could precisely describe the industry's pricing behavior in all market situations. Instead, the magnitude of the price increase is assumed to be at a level which would maintain the industrywide initial return on sales[2/]. This pricing strategy is incorporated in the following algorithm:

$$\frac{dP}{P} = \frac{\sum_{i=1}^{n} ACC_i}{\sum_{i=1}^{n} TC_i} \qquad \text{(Equation 2)}$$

where

$$TC_i = R_{1i}\,(1-PM_1) \qquad \text{(Equation 3)}$$

where

$\frac{dP}{P}$ = industry-wide price increase

ACC_i = annual compliance cost of plant i

TC_i = total cost of goods sold for plant i

R_{1i} = pre-compliance sales revenue of plant i

[2/] Because of variation of unit compliance costs among plants in the industry some plants will be affected more than others by the regulations, as described in Figure 2-2.

PM_1 = industry average pre-compliance profit margin

n = total number of plants in the product group

The values of R_{1i} were collected in the EPA industry survey, and PM_1 is estimated based on discussions with industry representatives and analysis of industry level data from Census of Manufactures and the Federal Trade Commission. The methodology for estimating PM_1 is explained in detail in Appendix C.

This price change algorithm implies some important dynamics in the interaction of competing firms in determining prices. Figure 2-2 illustrates how the model assimilates the differential compliance costs of four plants producing a similar product. Assume initially that each plant will raise its price from P_1 to an amount equaling the compliance cost per unit of its production. Demand would then tend to shift from plants C and D to plants A and B because their prices are now substantially less. As a result of this shift, plants C and D would be under pressure to lower their prices while plants A and B would be able to raise their prices. An equilibrium price, P_2, will be established, with plants C and D absorbing part of their compliance costs. In this manner, the model serves as the basis for estimating the price and production impacts for each product group as well as the basis for identifying plants that may have to absorb a significant portion of their cost of compliance.

Some of the plants in the industry are multi-product plants. To estimate the industry-wide price increase for each product group, these plants' total revenues and compliance costs are segregated and allocated to the appropriate product groups. Because the breakdown of plant flow rate by product is not available, it is assumed that compliance costs are proportionate to production volume and allocated to each product group accordingly.

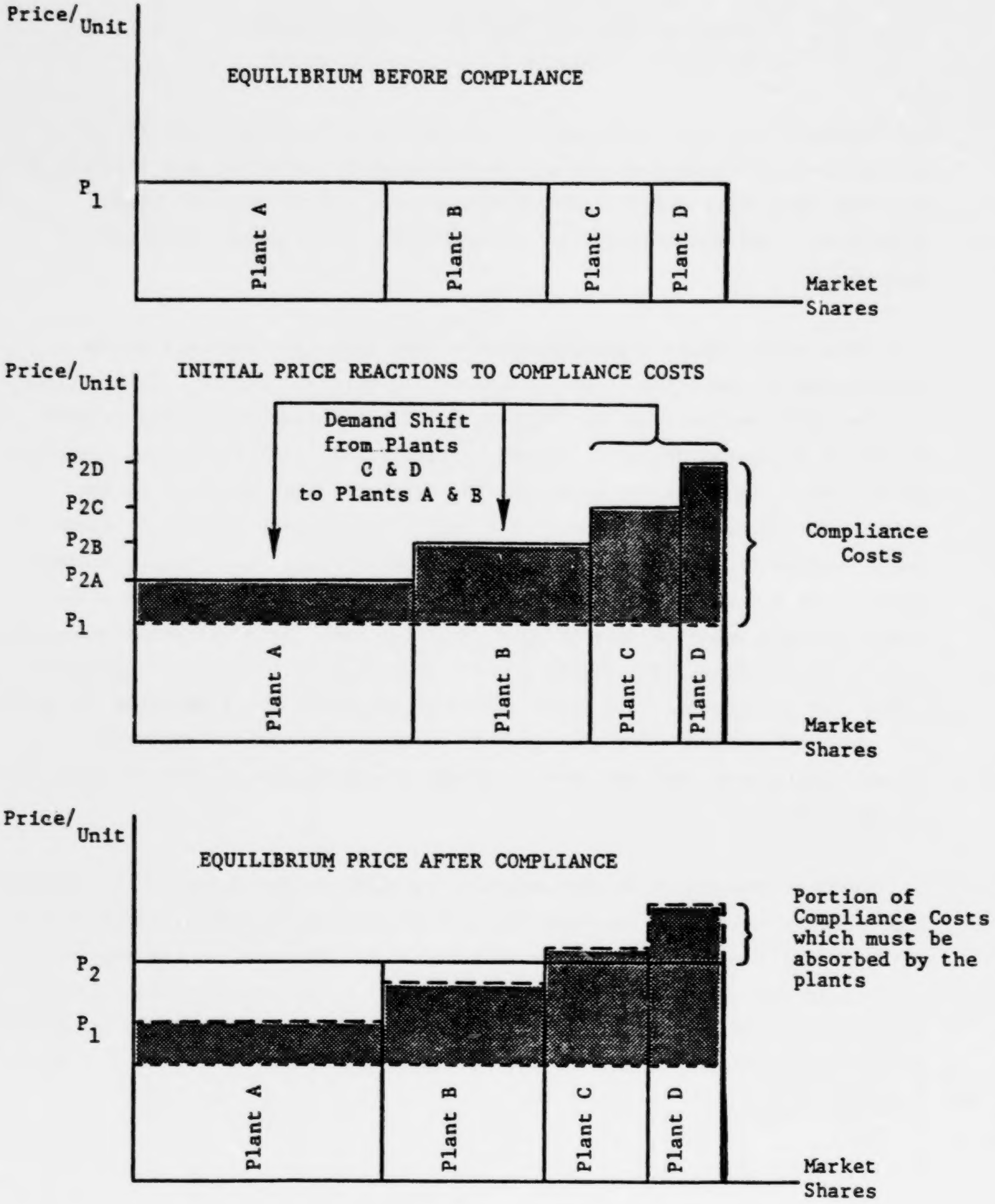
Price/Unit
EQUILIBRIUM BEFORE COMPLIANCE
P1
Plant A
Plant B
Plant C
Plant D
Market Shares
Price/Unit
INITIAL PRICE REACTIONS TO COMPLIANCE COSTS
Demand Shift from Plants C & D to Plants A & B
P2D
P2C
P2B
P2A
P1
Compliance Costs
Plant A
Plant B
Plant C
Plant D
Market Shares
Price/Unit
EQUILIBRIUM PRICE AFTER COMPLIANCE
Portion of Compliance Costs which must be absorbed by the plants
P2
P1
Plant A
Plant B
Plant C
Plant D
Market Shares

FIGURE 2-2 PRICE AND MARKET SHARE ADJUSTMENTS

Using the basic price elasticity equation and the dP/P ratios calculated above, the rate of change in quantity demanded dQ/Q for each product group is determined as follows:

$$E = \frac{dQ}{Q} \div \frac{dP}{P} \qquad \text{(Equation 4)}$$

$$\frac{dQ}{Q} = \frac{dP}{P} \times E \qquad \text{(Equation 5)}$$

where E = Coefficient of price elasticity of demand.

Since all plants in an industry group would raise their prices by the group-wide price increase dP/P, it is initially assumed that each plant in a product group would experience the same proportionate reduction in quantity dQ/Q.

It is necessary to determine if the key parameters in industry structure would change significantly during the 1980's. Projections of industry conditions begin with a demand forecast. The demand during the 1980's is estimated via trend analysis and market research analysis. It is determined from the projections of industry conditions that only minor changes in market structure would occur in the base case. For this reason it is concluded that the market structure previously described can be used to determine price changes due to the regulations.

The post-compliance market price levels are used, in a later step, to assess the financial condition of individual aluminum forming facilities.

2.4 STEP 3: COST OF COMPLIANCE ESTIMATES

Investment and annual compliance costs for three of the six identified treatment options were estimated. A summary description of the control and treatment technologies and assumptions for these compliance cost estimates appear in Chapter 5.

2.5 STEP 4: PLANT-LEVEL PROFITABILITY ANALYSIS

The basic measure of financial performance used to assess the impact of the regulations on the profitability of individual plants is return on investment (ROI). The technique involves a comparison of the measure after compliance with a minimum required return on investment.

The return on investment is defined as the ratio of annual profits before taxes to the total assets of a plant. This ratio is based on accounting income rather than cash flows and it does not account for the timing of cash flows, thereby ignoring the time value of money. However, this technique has the virtues of simplicity and common usage in comparative profitability analyses of financial entities. Because of lack of data on individual plant profits, and lack of evidence on the difference in profit rate among product groups, a common baseline rate of return on assets is assumed for all plants. Appendix C explains in detail the methodology for estimating the industry baseline profit.

The profit impact is assessed by calculating the after-compliance ROI for each plant and comparing it to a threshold value based upon general long-term interest rates in the economy. Plants with after-compliance ROI below the threshold value are considered potential plant closures. The underlying assumption is that plants cannot continue to operate as viable concerns if they are unable to generate a minimum return on investment that is at least equal to the opportunity cost of their investment alternatives. The opportunity cost is assumed to be equal to the rate of a risk-free investment (such as Treasury bonds) plus a risk-premium factor. It should be noted that the pre-compliance ROI is the same for each plant in the industry; the post-compliance ROIs, however, reflect plant-specific compliance cost estimates.

The risk adjusted opportunity cost is assumed to be 8 percent after tax return on the liquidation value of stockholders' equity. The 8 percent targeted return on equity investment is based on a 6.7 percent risk-free rate for 3-year Treasury bonds for 1977 plus a 1.2 percent risk-premium factor (see Appendix B). The year 1977 was selected for both the industry baseline profit and the cost of capital estimates because it was neither a cyclical peak year nor a cyclical trough year and therefore seemed to represent a normal year for both the aggregate economy and the aluminum industry. Given three critical assumptions, an 8 percent after-tax return on the liquidation value of the equity requires a before tax ROI of 2.7 percent. These assumptions are:

- stockholders' equity of aluminum forming firms represents about 45 percent of total assets[3]
- the average corporate tax rate is 40 percent[3]
- the average liquidation values of the plant assets are 75 percent of their book values.[4]

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[3] 1974-1982 average for three major aluminum producers.

[4] The assumption of 75 percent liquidation value of plant assets is based on the following assumptions:

- Average book value (net of depreciation) of fixed assets is 30 percent of total assets (see Table C-1 in Appendix C) and salvage value is zero. Since the average corporate tax rate is 40 percent, the liquidation value of fixed assets will be 40 percent of book value as the result of tax-writeoff benefit.
- Average book values of inventories and other current assets (i.e., cash, short-term investments, receivables, etc.) are 35 percent of total assets, and their liquidation value are assumed to be 90 percent of book values.

Based on the above assumption, the liquidation value of total assets is estimated to be 75 percent as shown below:

	Book Value	Liquidation Value
Fixed Assets	30	12.0 (30 x 0.4)
Inventories	35	31.5 (35 x 0.9)
Other Current Assets	35	31.5 (35 x 0.9)
Total Assets	100	75.0

Appendix B describes the methodology that led to this ROI threshold level.

The after compliance ROI (ROI_{2i}) is estimated for each plant using the following equations:

$$ROI_{2i} = \frac{PROFIT_{1i} + DPROFIT_i}{A_i + CCI_i} \qquad \text{(Equation 6)}$$

where $PROFIT_{1i}$ = Pre-compliance profit of plant i
$DPROFIT_i$ = Change in profit of plant i
A_i = Pre-compliance assets value of plant i
CCI_i = Compliance capital investment for plant i

The variables in Equation (6) are further defined as follows:

$$PROFIT_{1i} = R_{1i} \times PM_{1i} \qquad \text{(Equation 7)}$$

$$\begin{aligned} DPROFITi &= (R_{2i} - a_i P_{1i} Q_{2i} - FC_i - ACC_i) - (R_{1i} - a_i P_{1i} Q_{1i} - FC_i) \\ &= (R_{2i} - R_{1i}) - (a_i \times E \times \frac{dP}{P} \times R_{1i}) - ACC_i \end{aligned} \qquad \text{(Equation 8)}$$

$$R_{2i} = R_{1i} \left(1 + \frac{dP}{P} \right) \left(1 + \frac{dP}{P} E \right) \qquad \text{(Equation 9)}$$

where R_{1i} = Pre-compliance revenue of plant i
R_{2i} = After-compliance revenue of plant i
PM_{1i} = Pre-compliance return on sales of plant i
P_{1i} = Pre-compliance price of plant i
Q_{1i} = Pre-compliance production of plant i
Q_{2i} = After-compliance production of plant i
a_i = Variable cost to pre-compliance price ratio of plant i
FC_i = Fixed cost of production of plant i
ACC_i = Annual compliance cost of plant i
$\frac{dP}{P}$ = Product group price increase
E = Product group price elasticity coefficient of demand

The values of Q_{1i} and R_{1i} were collected in the EPA industry survey, while dP/P is calculated by Equation (2) presented in Section 2.3. In the absence of plant-specific data, the values of A_i, PM_{1i} and a_i are product group averages estimated from Census of Manufactures, Federal Trade Commission, company published financial data, and various inputs from industry sources. The methodology for estimating A_i and PM_{2i} is explained in detail in Appendix C. Finally, the demand price elasticity E is estimated econometrically in Chapter 4.

A low ROI for a given plant does not, by itself, necessarily imply that the plant will close. As discussed in Section 2.8, actual plant closure decisions made by individual companies are usually based on many factors. Additionally, actual baseline profit rates vary among plants. However, the profitability ratio (ROI) relates profits to plant total assets, and provides a means of evaluating the relative impact of required pollution control expenditures.

2.6 STEP 5: CAPITAL REQUIREMENTS ANALYSIS

In addition to analyzing the potential for plant closures from a profitability perspective, it is also necessary to assess the ability of firms to make the initial capital investment needed to construct and install the required treatment systems. Some plants which are not initially identified as potential closures in the profitability analysis may encounter problems raising the amount of capital required to install the necessary treatment equipment. The limit on a given firm's ability to raise capital to finance investment expenditures at a given plant is quite variable, depending upon factors such as the firm's capital structure, profitability, future business prospects, the industry's business climate, the characteristics of the financial markets and the aggregate economy, and the firm management's relationships with the financial community. The precise limit, considering all these factors, is ultimately judgmental. Even given firm-specific data, a limit on a firm's ability (or willingness) to raise funds for capital investment would be difficult to estimate.

In this study, the analysis of capital availability is based on the "fixed charge coverage" ratio which is defined as the ratio of earnings before interest and taxes to interest payments. The "fixed charge coverage" ratio does not provide precise or universal conclusions regarding a firm's ability to make the investments. However, this ratio provides a good indication of the relative burden created by the compliance requirement, and is often used by lenders to evaluate a firm's ability to incur additional debt. Firms with after-compliance fixed charge coverage ratios greater than 2 are generally considered solvent and worthwhile credit risks. While this ratio is generally applied at the firm level, it is applied to individual plants in this study.

2.7 STEP 6: PLANT CLOSURE ANALYSIS

The plant level analysis examined the individual production units in each product group to determine the potential for plant closures and profitability changes. The decision to close a plant, like most major investment decisions, is ultimately judgmental. This is because the decision involves a wide variety of considerations, many of which cannot be quantified or even identified. Some of the most important factors are:

- Profitability before and after compliance
- Ability to raise capital
- Market and technological integration
- Market growth rate
- Other pending Federal, state, and local regulations
- Ease of entry into market
- Market share
- Foreign competition
- Substitutability of the product
- Existence of specialty markets.

Many of these factors are highly uncertain, even for the owners of the plants. However, this analysis is structured to make quantitative estimates of the first two factors, as described above, and to qualitatively consider the importance of some others. In this analysis, the first two factors are given the greatest amount of weight and the importance of the other factors varies from plant to plant.

2.8 STEP 7: OTHER IMPACTS

"Other impacts" include economic impacts which flow from the basic price, production, and plant level profitability changes. These impacts include impacts on employment, communities, industry structure, and balance of trade.

The estimate of employment effects follows directly from the outputs of the industry level analysis and the plant closure analysis. Employment data for production facilities projected to close are available from the EPA 308 Survey.

Community impacts result primarily from employment impacts. The critical variable is the ratio of aluminum forming industry unemployment to total employment in the community. Data on community employment are available through the Bureau of the Census and the Bureau of Labor Statistics.

The assessment of industry structure changes is based on examination of the following before and after compliance with the regulation:

- Numbers of firms and plants
- Industry concentration ratios
- Effects of plant closures on specialty markets.

A decrease in the first factor and an increase in the second would indicate an increase in industry concentration and may change the pricing behavior of the industry. Such potential changes were qualitatively evaluated.

Imports and exports can be important factors of pricing behavior in the aluminum forming industry. The role of these variables is qualitatively evaluated in Chapter 3 of this report. Basically, impacts on imports and exports are a function of the change in the relative prices charged by domestic versus foreign producers. Therefore, the assessment of foreign trade impacts in based on the relative price effects.

2.9 STEP 8: NEW SOURCE IMPACTS

Newly constructed plants and plants undergoing substantial modifications will be subject to NSPS/PSNS guidelines. The effects these guidelines will have upon new plant construction in the aluminum forming category are analyzed in this step.

For the purpose of evaluating new source impacts, compliance costs of new source standards are defined as incremental costs over the costs of selected standards for existing sources (i.e., Treatment Option 2). The impacts of new source regulations are then determined by comparing compliance costs of a normal plant to its revenues and profit. Section 8 of the Development Document explains in detail the composition of the aluminum forming normal plants.

2.10 STEP 9: SMALL BUSINESS ANALYSIS

The Regulatory Flexibility Act (RFA) of 1980, (P.L. 96-354) which amends the Administrative Procedures Act, requires Federal regulatory agencies to consider "small entities" throughout the regulatory process. The RFA requires an initial screening analysis to be performed to determine if a substantial number of small entities will be significantly impacted. If so, regulatory alternatives that eliminate or mitigate the impacts must be considered. These objectives are addressed in this step by identifying the economic impacts which are likely to result from the promulgation of BPT, BAT, NSPS, PSES, and PSNS regulations on small businesses in the aluminum forming category. The primary economic variables covered are those analyzed in the general economic impact analysis such as plant financial performance, plant closures, and unemployment and community impacts. Most of the information and analytical techniques in the small business analysis are drawn from the general economic impact analysis which is described above and in the remainder of this report. The specific conditions of small firms are evaluated against the background of general conditions in the aluminum forming markets.

A specific problem in the methodology is the development of an acceptable definition of small entities. The Small Business Administration's standard definition of small entities in the aluminum forming industry is based on company size, and size is measured by the number of employees. However, alternative definitions can be used if they would be more appropriate. This report uses a definition of small business which is more consistent with the overall economic impact analysis of pollution control requirements, and which uses more readily available data: plants are used as the entities of analysis, rather than companies, and size is measured by production, rather than employees.

More specifically, because of economies of scale in pollution control technologies, unit compliance costs generally increase significantly as plant size decreases. Because the impacts of control requirements are more closely related to plants than companies and closure decisions are generally based on the profitability of a plant and information is collected on a plant basis, the basic analysis of impacts is done on the plant as a unit. In addition, pollutant loadings and the cost of waste treatment facilities tend to be more closely related to production than employment; hence, production is used as a measure of size.

For the aluminum forming industry, several alternative size definitions for plants based on plant output volume are selected for examination. These are: plants with production less than 200,000 pounds, 500,000 pounds, 3 million pounds, 5 million pounds, 7 million pounds, 10 million pounds, and 15 million pounds annually. The use of several different size definitions provides EPA with alternatives in defining small aluminum forming plants for purposes of regulation development.

The impacts on small plants under each definition are assessed by examining the distribution by plant size of the number of aluminum forming plants, plant revenues, compliance costs and potential closures from regulations.

3. INDUSTRY CHARACTERISTICS

3.1 OVERVIEW

This chapter describes the operational characteristics of plants and firms in the aluminum forming industry, the determinants of demand for aluminum forming products, and the price determining behavior of the industry. The primary operational characteristics include the number, size, and locations of plants and firms, the nature of the production processes, trends in production technology, degree of integration and industry concentration, and financial performance. The primary determinants of demand are the nature of the end-use markets, the nature of competitive products, price elasticity, and the role of imports and exports. The industry and market characteristics are pertinent to determining industry behavior when faced with additional pollution control requirements. This information is used in Chapter 4 to describe the expected characteristics of the industry in the 1985 to 1990 period, and in Chapter 6 to estimate the potential economic impacts of the proposed regulations.

The primary economic unit considered in this study is the individual establishment or product line. This is the basic unit around which capital budgeting decisions are made. That is, a single-plant or multi-plant firm will make decisions regarding opening, closing or modifying operations on a plant-by-plant basis. For example, a specific plant considered unprofitable for one company may still be a viable operation for another, and if sold, may remain in operation. In addition, financial and economic characteristics at the company and industry levels must also be examined because they affect investment decisions at the plant level. By examining some basic industry parameters such as number, size, and location of plants and firms, employment, and financial characteristics, this chapter provides the basic descriptive information used to model the pertinent behavioral characteristics which lead to plant closings and other economic impacts.

3.2 PLANT CHARACTERISTICS

As indicated in Chapter 1, the aluminum forming industry as defined in this study includes the plants that roll, draw, extrude, and forge aluminum semi-fabricated products. Figure 3-1 describes the typical production processes employed by the aluminum forming plants (also often referred to as aluminum mill product plants).

As shown in Table 3-1, the Department of Commerce Census of Manufactures indicates that there were about 300 operating aluminum forming plants in 1977. These plants employ about 51,000 production workers and 65,000 employees overall. Table 3-2 presents the distribution of the aluminum forming plants by employment size. The aluminum sheet, plate, and foil segment (SIC 3353) is dominated by large plants. Thirty-three percent of the plants in this industry segment have over 500 employees and account for over 85 percent of total industry shipments in 1977. The other segments are characterized by a significant number of small and medium sized plants (i.e., those employing fewer than 500 employees). Plants in all segments also appear to be highly specialized, with specialization ratios ranging from 88 to 94 percent.

In terms of geographic concentration, the majority of the aluminum forming plants are located in the Midwest and Northeast portions of the United States (see Figure 3-2).

EPA's survey of the aluminum forming industry indicates there were 279 aluminum forming plants in operation in 1977[1/]. For 248 plants that reported employment information, the number of production workers totaled about 28,600 people. This would project to 31,200 production employees for 279 plants, considerably lower than the Census of Manufactures figure. The reasons for the difference are not known at this time.

3.3 FIRM CHARACTERISTICS

The Department of Commerce estimates of the number of aluminum forming firms and plants are contained in Table 3-1. The extruded shapes group has

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[1/] Since then, eight plants were found to have either shut down or discontinued their aluminum forming operations.

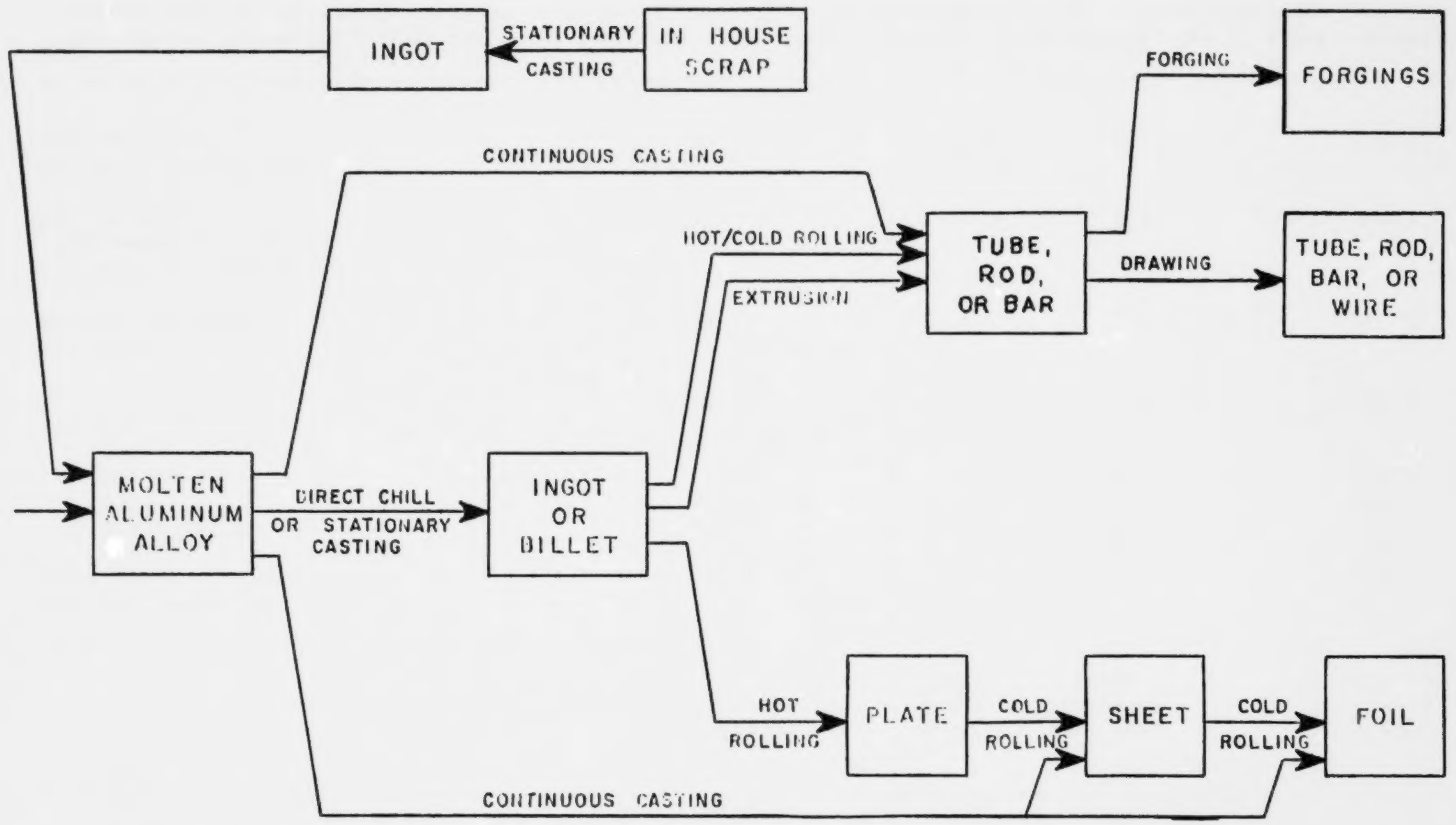
INGOT
STATIONARY CASTING
IN HOUSE SCRAP
FORGING
FORGINGS
CONTINUOUS CASTING
HOT/COLD ROLLING
EXTRUSION
TUBE, ROD, OR BAR
DRAWING
TUBE, ROD, BAR, OR WIRE
MOLTEN ALUMINUM ALLOY
DIRECT CHILL OR STATIONARY CASTING
INGOT OR BILLET
HOT ROLLING
PLATE
COLD ROLLING
SHEET
COLD ROLLING
FOIL
CONTINUOUS CASTING

FIGURE 3-1. ALUMINUM FORMING PROCESS

TABLE 3-1

ALUMINUM FORMING INDUSTRY CHARACTERISTICS, 1977

	Number of Companies	Number of Establishments	Number of Employees Total (000)	Number of Employees Production (000)	Value of Shipments ($ million)
SIC 3353. Aluminum Sheet, Plate and Foil	30	53	31.4	25.0	5,924.0
Plates		2	NA	NA	NA
Sheet and Strip		29	28.1	22.3	5,287.0
Foil		10	3.0	2.4	588.9
Welded Tube		5	0.3	0.2	38.4
SIC 3354. Aluminum Extruded Products	129	193	26.5	21.2	2,050.0
SIC 3355. Aluminum Rolling and Drawing	18	22	4.7	3.6	1,001.0
SIC 33571. Aluminum and Aluminum-Base Alloy Wire and Cable	NA	12	1.3	0.9	244.6
SIC 3463. Nonferrous Forgings	43	47[a]	5.4[a]	4.2[a]	456.7[b]

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[a] Not all nonferrous forging plants actively or regularly forge aluminum. Consequently, the 47 plants reported is an overestimate of the number of aluminum forgers; similarly, the employees data are also overestimated.

[b] Aluminum forgings value of shipments represent 45 percent of 1977 nonferrous forgings shipments.

Source: U.S. Department of Commerce, 1977 Census of Manufactures.

TABLE 3-2

NUMBER OF ALUMINUM MILL PRODUCT PLANTS BY EMPLOYMENT SIZE, 1977

	Aluminum Sheet, Plate, and Foil (SIC 3353)			Aluminum Extruded Products (SIC 3354)			Aluminum Rolling and Drawing, n.e.c. (SIC 3355)			Nonferrous Wiredrawing[a] (SIC 3357)			Nonferrous Forgings[b] (SIC 3463)		
Plant Size	No. of Plants	% of Total Number	% of Value of Shipments	No. of Plants	% of Total Number	% of Value of Shipments	No. of Plants	% of Total Number	% of Value of Shipments	No. of Plants	% of Total Number	% of Value of Shipments	No. of Plants	% of Total Number	% of Value of Shipments
Establishments with															
1 - 19 Employees	8	15	1.4	47	24	0.8	7	32	N/A	101	24	0.8	16	35	0.9
20 - 99 Employees	9	17		76	39	17.2	4	18	N/A	125	29	8.7	14	30	7.1
100 - 499 Employees	18	34	12.5	60	31	53.4	8	36	N/A	170	41	71.0	14	30	34.0
500 - 999 Employees	10	19	25.2	7	4	15.7	2	9	N/A	18	4		2	3	57.8
over 1,000 Employees	8	15	60.6	3	2	12.7	1	5	N/A	7	2	19.0	1	2	(D)
TOTAL	53	100	100.0	193	100	100.0	22	100	100.0	421	100	100.0	47	100	100.0
Coverage Ratio [c]			99			92			65			93			67
Specialization Ratio [d]			92			88			94			94[e]			87

[a] Includes all nonferrous wiredrawing. Less than 20% of quantity shipped is aluminum wire. EPA's survey identified 47 plants which do wiredrawing.

[b] Includes all nonferrous forging. Aluminum forging accounted for 45% of total value of shipments. EPA's survey identified 17 plants which do aluminum forging

[c] Coverage ratio is ratio of a given industry's primary product shipments to total shipments of these products by all industries.

[d] Specialization ratio is ratio of primary product shipments to total product shipments for primary plus secondary products.

[e] The figure may not be representative of the degree of specialization of aluminum wiredrawing plants.

(D)Withheld to avoid disclosing operations of individual companies. Value for this group is included in the previous group.

Source: U.S. Bureau of the Census, 1977 Census of Manufactures/Industry Statistics.

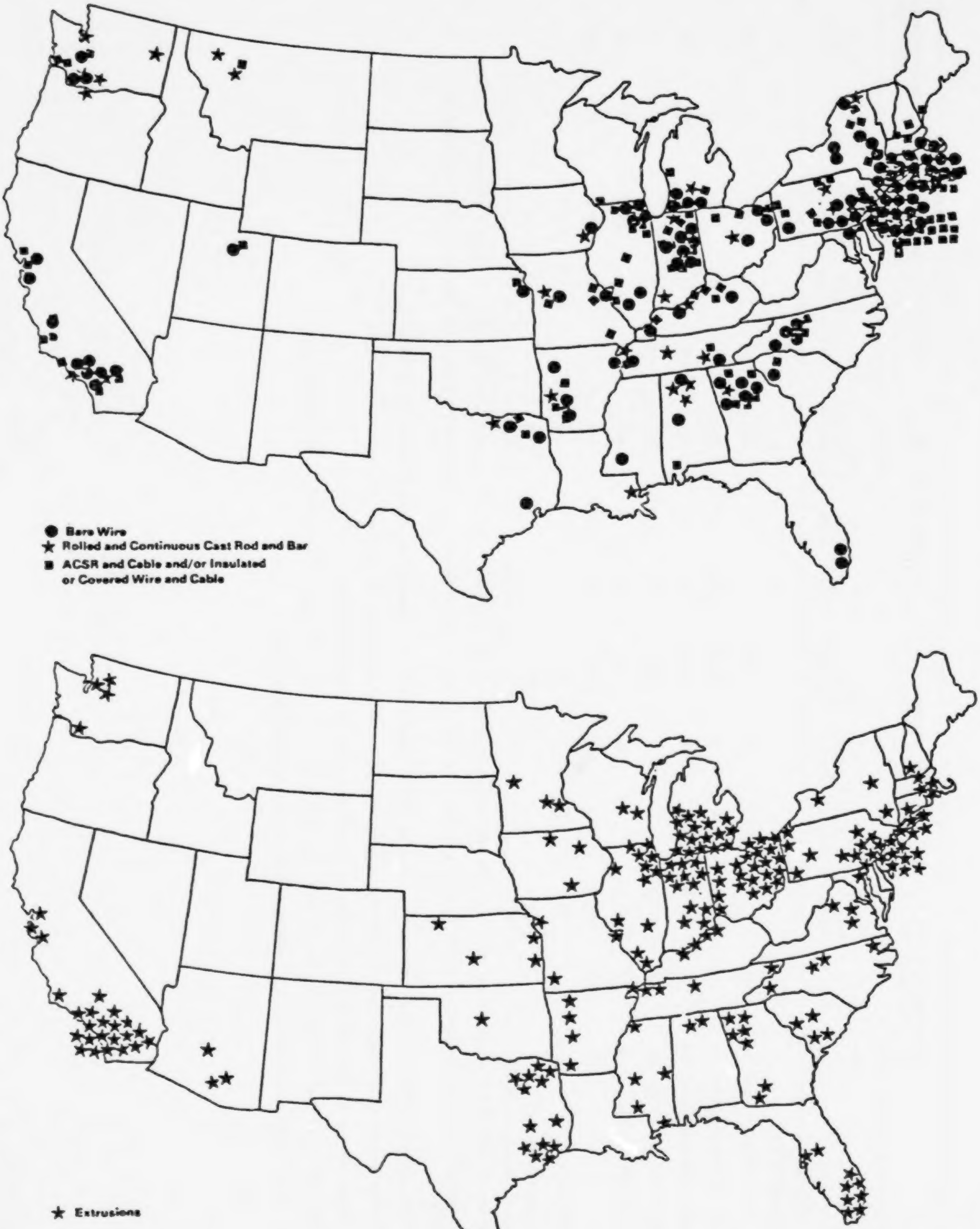
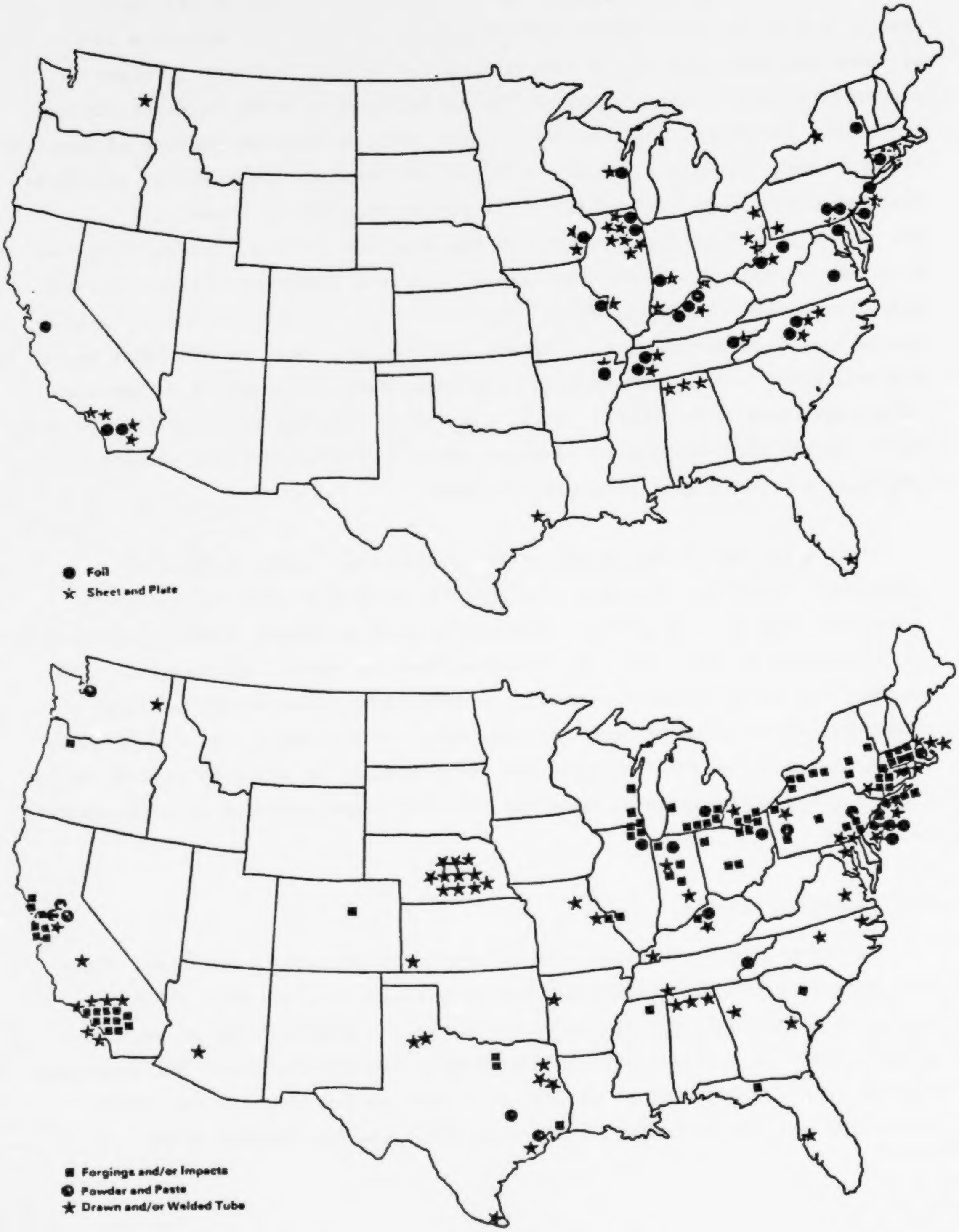

● Bare Wire
★ Rolled and Continuous Cast Rod and Bar
■ ACSR and Cable and/or Insulated or Covered Wire and Cable
★ Extrusions

FIGURE 3-2
GEOGRAPHICAL LOCATION OF ALUMINUM FORMING PLANTS

FIGURE 3-2 (Continued)


● Foil
☆ Sheet and Plate
■ Forgings and/or Impacts
● Powder and Paste
★ Drawn and/or Welded Tube

SOURCE: The Aluminum Association

the largest number of plants and firms with 193 plants owned by 129 firms. Table 3-3 lists the concentration ratios computed for each of the major product groups in the aluminum forming industry. With the exception of extruded products, the United States aluminum forming industry is highly concentrated with a large share of the market held by a few horizontally and vertically integrated multi-national firms such as Aluminum Company of America (ALCOA), Reynolds Metals, Kaiser Aluminum and Chemical Corporation, and Alcan Aluminum Corporation (subsidiary of Aluminium Company of Canada, Ltd.). The degree of diversification outside the aluminum industry varies among the aluminum companies. Of the four largest aluminum producers, Kaiser has the most diversified operations while the other three companies are more highly specialized in aluminum processing and fabricating. Most of the other major aluminum fabricators, such as Arco Petroleum (owns Anaconda), R.J. Reynolds Industries (owns R.J. Archer, Inc.), and Martin Marietta Corporation, are also highly diversified companies. However, most of the small aluminum extrusion companies are not significantly diversified.

Most aluminum forming products are produced by highly integrated companies. Table 3-4 indicates that the 12 integrated aluminum producers (companies that produce primary aluminum as well as formed products) accounted for 75 percent of the total U.S. aluminum forming product shipments in 1980. However, the market predominance of the integrated firms is not uniform throughout the various product subcategories. For example, the market share of integrated firms for the sheet and plate segment is about 85 percent while their corresponding share of tube and extruded shape products is approximately 42 percent.

3.4 FINANCIAL PROFILE

To assess the financial status of the aluminum forming industry, financial data from publicly available corporate annual reports were collected. Table 3-5 illustrates the financial ratios of the sample firms by product group [return on equity (ROE), profit margin (profits to sales) and long-term debt to equity (D/E) ratios] for the 1976-1978 period compared to similar ratios for all manufacturing firms calculated from the Federal Trade

TABLE 3-3

CONCENTRATION RATIOS OF ALUMINUM FORMING INDUSTRY, 1977

Class of Product	Percent of Value of Shipments Accounted for by 4 largest Companies	8 largest Companies	20 largest Companies
Aluminum Sheet, Plate, and Foil (SIC 3353)	73	90	99+
Aluminum Sheet	75	91	100
Aluminum Plate	87	(D)	100
Aluminum Foil	74	95	100
Aluminum Extruded Products (SIC 3354)	37	54	73
Rod, Bar, and other Extruded Shapes	37	56	76
Extruded and Drawn Tube	59	76	95
Aluminum Rolling and Drawing, n.e.c. (SIC 3355)	81	93	99+
Nonferrous Wiredrawing and Insulating (SIC 3357)	37	52	74
Aluminum Wire (SIC 33571)	64	87	(D)
Nonferrous Forgings (SIC 3463)	61	77	90

(D) Withheld by Bureau of the Census

Source: U.S. Bureau of the Census, 1977 Census of Manufactures.

TABLE 3-4

GROSS SHIPMENTS OF ALUMINUM FORMING PRODUCTS BY TYPE OF PRODUCER, 1980

	Gross Shipments (Millions of lbs)		
	Total	By Integrated Producers	By Nonintegrated Producers
Total	10,917	8,151 (75%)	2,766 (25%)
Sheet and Plate	6,282	5,348 (85%)	934 (15%)
Foil	830	733 (88%)	97 (12%)
Rod, Bar (Rolled and Continuous), and Bare Wire	628	482 (77%)	146 (23%)
Cable and Insulated Wire	763	540 (71%)	223 (29%)
Tube and Extruded Products	2,281	959 (42%)	1,322 (58%)
Forgings	133	89 (67%)	44 (33%)

Note: Numbers in parentheses are market share proportions.

Source: Department of Commerce, Current Industrial Reports: Aluminum Ingot and Mill Products, 1981.

TABLE 3-5

SELECTED MEASURES OF FINANCIAL STATUS OF ALUMINUM FORMING INDUSTRY BY PRODUCT GROUP

Product Groups	No. of Firms in Sample	No. of Firms w/ ROE Worse Than All Manufacturing			No. of Firms w/ Profit Margin Worse Than All Manufacturing			No. of Firms w/higher D/E Than All Manufacturing		
		1978	1977	1976	1978	1977	1976	1978	1977	1976
Sheet and Plate	15	8	11	12	7	10	10	9	12	11
Foil	13	5	8	8	4	7	7	7	7	7
Tube and Extruded Shapes	38	19	21	24	22	27	26	29	26	29
Rod and Bar	10	5	7	8	3	8	8	8	8	10
Wire and Cable	14	8	10	9	6	11	10	10	10	11
Forgings	7	1	4	4	4	5	5	6	6	7

Source: Federal Trade Commission Quarterly Financial Report and Corporate annual reports.

Commission's Quarterly Financial Report. This time period is chosen because it reflects some, but not extreme, cyclical behavior in the aggregate economy and because it is the approximate time period of the EPA survey of the aluminum forming industry. The data in this table are derived from Appendix A, which lists the data for the specific firms. In general, the profit performances (ROE and profit margin) of most companies with aluminum forming operations are worse than the all manufacturing average. In terms of capital structure, the sample firms are generally more leveraged and exhibit higher debt to equity ratios than the overall manufacturing average.

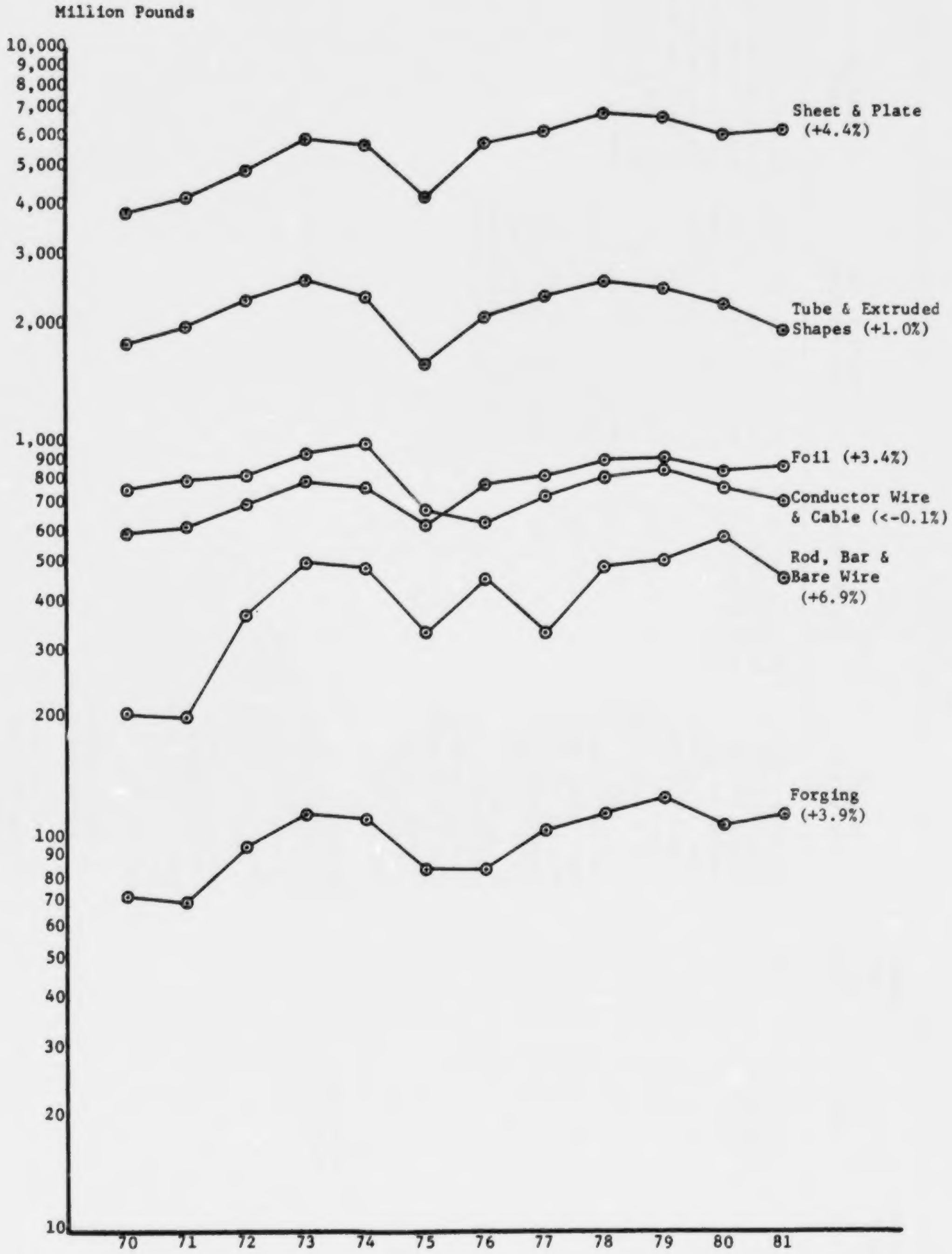
3.5 PRODUCTS AND MARKETS

Since the 1880s, when commercially feasible processes were developed for fabricating aluminum, aluminum has become the second most widely used metal (steel being the highest). The variables influencing present demand conditions are closely related to the metallurgical properties of aluminum, which make its use more advantageous in many applications than that of other substitutes. In general, the use of aluminum forming products advanced in areas where light weight, strength, high electrical conductivity, corrosion resistance, heat reflectivity, easy maintenance, economy, and aesthetic appeal were desired.

Figure 3-3 presents 1970-1981 consumption patterns and growth rates for the aluminum forming products. Most product groups showed healthy growth patterns, except conductor wire and cable consumption which remained virtually static, and rod, bar, and bare wire consumption which was highly erratic.

Table 3-6 provides a product-by-product summary of the market characteristics of the aluminum forming products, including average growth rates, major markets, reasons for growth, availability of substitutes, prospects for substitution, and foreign trade. Table 3-7 contains a more detailed breakdown of quantities consumed by major markets and uses for the six product groups.

In recent years, energy shortages and rising crude oil prices have fostered efforts to conserve energy which, in turn, have spurred demand for



Note: Value in parentheses represents 1970-1981 annual growth rate.

FIGURE 3-3. CONSUMPTION PATTERNS AND GROWTH RATES FOR ALUMINUM FORMING PRODUCTS, 1970-1981

TABLE 3-6. SALIENT MARKET CHARACTERISTICS OF ALUMINUM FORMING PRODUCTS

ALUMINUM PRODUCT GROUPS	1970-1981 AVERAGE GROWTH RATE (PERCENT)	MAJOR MARKETS	PERCENT OF TOTAL PRODUCT GROUP	REASONS FOR GROWTH	SUBSTITUTES	PROSPECTS FOR SUBSTITUTION	FOREIGN TRADE
Sheet & Plate	4.4	Containers & Packaging	45	Container & Packaging Market- Changes in food consumption patterns -- expansion of precooked can foods --, technological breakthroughs (i.e., easy to open can) and the metal's light weight along with its excellent thermal conductivity (i.e., easier to heat or chill) contributed to the increased utilization of aluminum in beverage can and food container applications.	Steel, copper, wood, brick, plastic vinyl, tin plate, glass	Aluminum's overall advantages over substitute materials (based on its metallurgical properties alone) will not suffice to discourage shifts towards the use of substitutes. High energy usage in manufacture, rising prices and periodic shortages of aluminum sheet and plate may increase the use of steel and plastic in building (siding), transportation, and beverage can applications.	Historically the U.S. has been a net exporter of sheet and plate. Temporary tight supplies in 1978 resulted in increases of imports for sheet and plate and a reversal of the U.S. position as a net exporter to a net importer.
		Building & Construction	21	Building & Construction Market - The characteristics of aluminum which result in construction and maintenance cost economics generated demand for the metal in the following applications: • The residential siding market • The load bearing structure members • Modular structure applications.			

TABLE 3-6. SALIENT MARKET CHARACTERISTICS OF ALUMINUM FORMING PRODUCTS (Continued)

ALUMINUM PRODUCT GROUPS	1970-1981 AVERAGE GROWTH RATE (PERCENT)	MAJOR MARKETS	PERCENT OF TOTAL PRODUCT GROUP	REASONS FOR GROWTH	SUBSTITUTES	PROSPECTS FOR SUBSTITUTION	FOREIGN TRADE
		Transportation	12	Transportation Market- Increasing awareness and legislation for energy conservation due to the metal's lightweight characteristics resulted in increased utilization and demand for aluminum in this market.			
Foil	3.4	Containers & Packaging	73	New product developments such as the retortable pouch resulted in increased demand for foil. A number of the new product developments were induced by energy shortages, taking advantage of the product's light weight, thermo-conductivity and insulating properties.	Plastic film, paper, copper, steel	Plastic film is the most likely prospect as a substitute for aluminum in containers and packaging applications. Rising prices of plastic, however, may inhibit substitution.	The U.S. has always been a net exporter of aluminum foil.
		Consumer Durables	10				
		Transportation	4				

TABLE 3-6. SALIENT MARKET CHARACTERISTICS OF ALUMINUM FORMING PRODUCTS (Continued)

ALUMINUM PRODUCT GROUPS	1970-1981 AVERAGE GROWTH RATE (PERCENT)	MAJOR MARKETS	PERCENT OF TOTAL PRODUCT GROUP	REASONS FOR GROWTH	SUBSTITUTES	PROSPECTS FOR SUBSTITUTION	FOREIGN TRADE
Tube & Extruded Shapes	1.0	Building & Construction Transportation	54 19	Low construction, installation and maintenance costs, as well as increased trends in off-site building activities (prefabrication), account for the increased demand for aluminum extruded shapes. Also, there is an increased emphasis for aluminum products in the highway safety area such as guard rails, lighting poles, etc. Other advantages of aluminum include light weight and resistance to corrosion.	Plastic, steel, wood, copper	Improved technology in precision molding of plastic parts and improved resin properties have placed plastic in an excellent position as a substitute. If plastic prices continue to be lower than those of aluminum, plastic market share should increase rapidly at the expense of both aluminum and steel.	The U.S. has always been a net exporter of tube and extruded shapes.
Rod, Bar & Bare Wire	Too erratic. No discernable pattern growth could be established.	Electrical Machinery & Equipment Building & Construction	21 14 10	Continued demand for rod, bar, and bare wire is attributed to extensive research efforts to develop new product applications designed to reduce production costs and improve efficiency.	Steel, copper, plastic, epoxy adhesive.	The success of new technological breakthroughs by the aircraft industry may determine how soon other industries could use epoxy adhesives which are lighter and cheaper instead of aluminum fasteners and screws.	The U.S. has always been a net exporter of rod, bar and bare wire. Shipments of these products to overseas markets accounted for approximately 20 percent of the domestic production.

TABLE 3-6. SALIENT MARKET CHARACTERISTICS OF ALUMINUM FORMING PRODUCTS (Continued)

ALUMINUM PRODUCT GROUPS	1970-1981 AVERAGE GROWTH RATE (PERCENT)	MAJOR MARKETS	PERCENT OF TOTAL PRODUCT GROUP	REASONS FOR GROWTH	SUBSTITUTES	PROSPECTS FOR SUBSTITUTION	FOREIGN TRADE
Conductor Wire & Cable	Fairly Static.	Electrical	95	The use of aluminum conductor wire was induced by the metallurgic properties of aluminum (i.e., high per pound conductivity and favorable strength-to-weight ratio. These properties made aluminum ideal for overhead transmission line applications.	Copper	For overhead transmission line applications, copper is more expensive and heavier than aluminum, consequently copper is not a viable substitute for aluminum. In regards to household wiring applications, copper is perceived by the public as a safer material with a better fire safety. However, aluminum is more economical. Therefore, competition of the two metals in this market is expected to continue to be strong.	The U.S. is and has always been a net exporter of aluminum conductor wire and cable.
Forgings	3.9	Transportation	74	Because of its high strength-to-weight property, aluminum forgings are preferred to other materials in applications such as pistons, automotive transmission parts, connecting rods, truck wheels, and aircraft landing gear.	Steel, magnesium, titanium, graphite composites	Limited due to advantageous life cycle cost of aluminum	Foreign trade in regards to aluminum forgings is insignificant.

TABLE 3-7. CONSUMPTION OF ALUMINUM MILL PRODUCTS BY MAJOR MARKET

Technical Process Subcategories	Economic/Financial Subcategories	1980 PRODUCT SHIPMENTS		1980 MARKETS FOR ALUMINUM		
		Quantity (10^6xlbs)	% of Total Market	Consumption (10^6xlbs)	Markets	Typical Uses
Rolling with Neat Oils Rolling with Emulsions	Sheet & Plate	5,977	57	1,251	Building & Construction	Sidings, roofings, awnings, canopies, mobile homes, highway signs
				715	Transportation	Truck, bus and trailer bodies, railcars, cargo containers, auto body panels, airplane wings
				334	Consumer Durables	Air conditioners, cooking utensils, pleasure boats
				204	Electrical	Electronic equipments, housings, chassis, panels
				288	Machinery & Equipment	Storage tanks, printing plates
				2,693	Containers & Packaging	Cans, can lids, bottle caps
				77	Other	
				426	Exports	
	Foil	840	8	29	Building & Construction	Insulation, solar screens
				31	Transportation	Air conditioners, radiators
				84	Consumer Durables	Heat exchanges for air conditioners and refrigerators
				23	Electrical	Condenser "plates" or windings, electrical coils
				16	Machinery & Equipment	Fin stock for heat exchanges
				614	Containers & Packaging	Foil wrap, retortable pouch. candy wrap, labels, collapsible tubes, cookware
				5	Other	
				38	Exports	
Extrusion	Extruded Shapes	1,900	18	1,176	Building & Construction	Windows, doors, screen frames, mobile homes, highway guard rails, light poles
				390	Transportation	Airplane frame, auto bumpers, cargo containers
				96	Consumer Durables	Furniture, tennis rackets
				68	Electrical	Transmission line towers, lighting fixtures
				88	Machinery & Equipment	Ladders, scaffolds
				-	Containers & Packaging	
				37	Other	
				25	Exports	
	Tube & Pipe	319	3	28	Building & Construction	Highway light standards, downspouts, drainage culverts
				25	Transportation	Air conditioner condensers, radiators
				83	Consumer Durables	Air conditioner coils, furnitures, bicycles, baseball bats
				56	Electrical	Transmission line towers, light sockets, flashlights, wire conduits
				87	Machinery & Equipment	Irrigation pipe, oil drilling pipe, heat exchanger equipment
				-	Containers & Packaging	
				15	Other	
				16	Exports	
Drawing with Neat Oils Drawing with Emulsions	Rod, Bar & Bare Wire	524	5	53	Building & Construction	Clothes lines, fences, screens, screws
				40	Transportation	Welding wire, screws
				20	Consumer Durables	Baskets, refrigerator trays, zippers
				108	Electrical	Coils, electrical wire, screws
				72	Machinery & Equipment	Connecting rods, bearings, and bushings
				7	Containers & Packaging	Wire
				79	Other	
				195	Exports	
	Conductor Wire & Cable	763	7	726	Electrical	Overhead and underground transmission lines, wire & cable
				37	Exports	
Forging	Forgings	107	1	1	Building & Construction	Pistons, connecting rods, automatic transmission parts, truck wheels, aircraft landing gears
				79	Transportation	
				2	Consumer Durables	
				1	Electrical	
				10	Machinery & Equipment	
				11	Other	
				3	Exports	

aluminum products used in energy saving technologies. Examples of aluminum forming products used for energy saving include such items as aluminum storm windows and doors, and automobile body and engine components (the metal's lightweight properties improve the gas mileage of automobiles).

Increased shipments to these and other end-use markets have caused a shift from under-utilization of capacity during the 1950s through the early 1970s, to capacity shortages in the aluminum industry during the late 1970s. However, the industry's capacity utilization remains largely dependent upon the aggregate economic conditions. During the 1980-81 recession, demand for aluminum forming products dropped sharply to cause an excess of capacity in the industry.

3.6 FOREIGN TRADE

As shown in Table 3-8, the United States has always been a net exporter of aluminum forming products and imports and exports have historically been a small factor in the domestic aluminum forming market. In recent years less than 10 percent of domestic consumption was from imports (see Table 3-9). Imports of aluminum forming products generally increase during periods of shortage in domestic supply. For example, as shown in Table 3-8, there were net imports of 142 million pounds of sheet and plate in 1978. Prior to this occurrence in 1978, the rod, bar, and bare wire product group is the only one of the six product groups for which imports accounted for more than 6 percent of consumption.

In addition to direct imports of aluminum mill products, a considerable amount of these products enter the U.S. indirectly via imported finished products, such as transportation equipment, computers, cameras, and electronic equipment. To the extent that U.S. share of the world markets for these products increase or decrease, demand for domestic aluminum forming products will increase or decrease.

3.7 PRICE DETERMINATION

Increased costs of aluminum forming will, in the whole or in part, be passed through to customers in the form of higher prices. The amount that can

TABLE 3-8

IMPORTS AND EXPORTS OF ALUMINUM FORMING PRODUCTS, 1970 - 1981
(Million of Pounds)

	Sheet and Plate			Foil			Rod, Bar, and Bare Wire		
Year	Imports	Exports	Net Exports	Imports	Exports	Net Exports	Imports	Exports	Net Exports
1970	136.3	231.1	94.8	28.0	4.0	-24.1	22.4	49.6	27.2
1971	126.7	249.8	123.1	25.8	4.2	-21.6	15.5	30.9	15.4
1972	138.5	242.7	104.2	24.5	4.9	-11.6	20.3	49.3	29.0
1973	99.5	327.9	228.4	18.4	8.1	10.3	15.8	74.1	58.3
1974	69.7	366.9	297.2	13.6	16.9	3.2	22.2	62.6	40.4
1975	107.1	276.3	169.2	45	12.4	5.9	15.3	73.1	57.8
1976	150.5	343.0	192.5	11.0	14.3	3.3	25.0	73.3	48.3
1977	128.7	344.3	215.6	9.8	13.1	3.3	21.7	42.7	21.0
1978	433.7	291.8	-141.9	21.5	11.9	-9.6	26.0	83.6	57.6
1979	357.3	404.5	47.2	17.9	20.6	2.6	44.9	91.6	46.7
1980	126.1	425.7	299.6	9.1	37.9	28.8	18.4	194.4	176.0
1981	247.2	411.4	164.2	13.4	21.3	7.9	47.6	127.2	79.6

TABLE 3-8

IMPORTS AND EXPORTS OF ALUMINUM FORMING PRODUCTS, 1970 - 1981

(Million of Pounds) (Continued)

	Tube and Extruded Shapes			Conductor Wire and Cable			Forging		
Year	Imports	Exports	Net Exports	Imports	Exports	Net Exports	Imports[1/]	Exports	Net Exports
1970	4.8	17.8	10.7	1.9	19.7	13.7	0	3.5	3.5
1971	3.6	16.7	6.9	.8	20.8	17.2	0	3.5	3.5
1972	4.4	15.6	7.7	.8	10.1	5.7	0	4.4	4.4
1973	3.5	29.3	16.4	.7	4.2	1.0	0	4.8	4.8
1974	1.8	35.9	17.9	1.5	8.5	3.6	0	4.3	4.3
1975	1.7	29.2	13.2	.9	27.4	23.9	0	4.2	4.2
1976	1.4	29.6	9.3	.5	27.6	23.0	0	3.4	3.4
1977	2.8	29.9	27.1	.4	58.1	57.7	0	5.6	5.6
1978	2.7	36.2	33.5	.1	56.1	56.0	0	--	--
1979	2.8	36.7	33.9	.1	30.6	30.5	0	3.5	3.5
1980	1.9	42.0	40.1	.1	39.1	29.0	0	3.2	3.2
1981	2.5	23.7	21.2	--	70.3	70.3	0	3.2	3.2

Source The Aluminum Association, Aluminum Statistical Review 1980.

[1/] Not reported. Assume to be zero.

TABLE 3-9

IMPORTS OF ALUMINUM FORMING PRODUCTS AS A PERCENT OF TOTAL CONSUMPTION, 1970-1981

(percent)

Year	Sheet and Plate	Foil	Rod, Bar, and Bare Wire	Tube and Extruded Shapes	Conductor Wire and Cable	Forgings
1970	3.8	5.4	9.8	0.3	0.3	NA
1971	3.3	4.8	6.6	0.2	0.1	NA
1972	3.0	4.0	6.4	0.2	0.1	NA
1973	1.8	2.6	3.8	0.1	0.1	NA
1974	1.3	2.1	5.3	0.1	0.2	NA
1975	2.8	0.9	6.0	0.1	0.1	NA
1976	2.8	1.6	6.6	0.1	0.1	NA
1977	2.2	1.4	7.4	0.1	0.1	NA
1978	6.7	2.6	6.5	0.1	*	NA
1979	5.7	1.8	11.0	0.1	*	NA
1980	2.3	1.1	4.9	0.1	*	NA
1981	4.3	1.6	14.7	0.1	NA	NA

*Less than .05 percent.

NA = Not available

Source: The Aluminum Association, Aluminum Statistical Review.

be passed through depends on the price-setting behavior within the industry (i.e. intra-industry competition) and the market acceptance of price increases as measured by the price elasticity of demand. The following discussions cover these topics.

3.7.1 Price Elasticity of Demand

The price elasticity of demand measures the degree of responsiveness of quantity demanded to price changes. An elasticity coefficient of between -1.0 and 0 refers to a generally inelastic (less responsive) market reaction to price increases, while a coefficient of -1 or less will portray an elastic (more responsive) market reaction. A price increase for a product with an inelastic coefficient will yield a less than proportional reduction in quantity demanded while a similar price increase for a product with an elastic coefficient will result in a more than proportional reduction in quantity demanded. For example, if a product with a price elasticity coefficient of -0.6 experiences a price increase of 2 percent, the quantity demanded will decrease by 1.2 percent (i.e., 0.6 times 2) which is less than the price increase.

In general, the price elasticity of intermediate products such as the aluminum forming products, are influenced by two main factors:

1) The number and closeness of substitutes
2) The proportion of the aluminum forming product cost in relation to the total cost of the final product.

Substitutions can occur at several levels from raw materials to intermediate to end products. At the raw or intermediate material level, manufacturers using aluminum forming products can either switch to other materials or redesign their products to reduce their dependence on aluminum. If increased aluminum prices cause increases in the prices of intermediate and end products, the quantity demanded of these products may decline. These effects are variable from one product to another, depending upon ease of substitution and the ratio of the aluminum forming product cost to the total cost of the end products. The greater this ratio, the greater the potential impact on the final product's price. Moreover, the greater this ratio, the greater the likelihood that aluminum users will consider or search for substitutes.

For this study, econometric models were used to estimate the demand elasticities for each of the six aluminum forming products and to project their demand for 1985 and 1990. A description of the model appears in Appendix D.

Table 3-10 summarizes the price elasticity estimates which are derived from the demand model. Except for the wire and cable product group, all the elasticity estimates are inelastic (i.e. less than one). This is consistent with our *a priori* expectations for each of the product groups. The long-run price elasticity estimates shown in Table 3-10 range from -.4 for the foil and forging groups to -1.1 for the conductor wire and cable group. These elasticity estimates, derived from the empirical model, are used in the impact analysis described in Chapter 6.

3.7.2 Industry Competition

As described in Chapter 2, the level of competition is assessed through the evaluation of industry concentration, product specialization, pricing practice, profitability, capacity utilization rates, and capital intensity.

The four-firm and eight-firm concentration ratios shown in Table 3-3 indicate that the products which account for most of the output of the aluminum forming industry are highly or moderately concentrated. Thus, the pricing and output decisions of each firm in the market will have significant effects on that of the other firms.

Most aluminum forming products are relatively undifferentiable. They have well-defined physical and performance properties that generally conform to standards specified by users. Thus, efforts at creating separate markets through such means as advertising and marketing do not significantly affect the price-setting behavior of firms in this industry.

TABLE 3-10

ALUMINUM PRODUCT GROUP PRICE ELASTICITY ESTIMATES

Aluminum Product Group	Long-Run Elasticities
Sheet and Plate	-.6
Foil	-.4
Tube and Extruded Shapes	-.9
Rod, Bar, and Bare Wire	-.8
Conductor Wire and Cable	-1.1
Forgings	-.4

Source: JRB Associates estimates.

It is difficult for a firm in the aluminum forming industry to increase its market share simply by a price reduction. This is because a price cut will usually be met by other firms in the industry. This condition hinders pricing competition and sometimes develops into what is known as "price leadership." A firm holding a large or the largest market share for a product acts as a "price leader". When the "price leader" raises or lowers quoted prices of the product, other major firms in the industry follow. The pricing history of the industry indicates that the action of price leaders seems to have been a significant determinant of pricing behavior.

Nevertheless, there is evidence of a certain degree of price competition in the industry. On previous occasions, price leaders' attempts to change prices failed due to consumer resistance, other firms' anticipation of consumer resistance to a price increase, or the reluctance of other firms to drop prices during periods of high capacity utilization. The discounting of orders, which has been a prevalent practice in the industry, especially in times of excess supply, is further evidence of competitive behavior. Comprehensive information is not available on the extent of discounting on an industry-wide basis since it is done on an individual firm basis and no publicly available records were available.

As shown in Section 3.4, profit rates in the aluminum forming industry are not excessive. In addition, the industry is highly cyclical and profitability varies with the economic activity.

Capital intensity varies among the product groups. For most of the industry's output it is high, with asset turnover ratios (i.e., sales to assets) about 1.5. This is an indication of difficulty of entry into this industry. Also, this suggests that firms consider it important to sustain high levels of capacity utilization; therefore, in periods of low demand, price competition may become an important factor.

3.7.3 Summary of Findings on Price Determination

The analysis of market structure and performance of the aluminum forming industry reveals some characteristics that are indicative of competitive markets and some that are indicative of imperfectly-competitive markets. The industry's characteristics that are indicative of imperfectly-competitive markets include generally inelastic demand, high concentration, high capital requirements (which indicate difficulty of entry into the market) and instances of "price leadership." At the same time, the industry exhibits characteristics of competitive pricing situations such as the existence of relatively homogeneous products, relatively "normal" profit rates, and periodic oversupply resulting in price discounts. Because of the conflicting information regarding the industry's market structure, the industry's pricing conduct cannot be classified specifically as clearly competitive or clearly non-competitive.

4. BASELINE PROJECTIONS OF INDUSTRY CONDITIONS

This section provides projections of conditions in the aluminum forming industry to 1990 under the assumption that there would be no water pollution control requirements resulting from the Clean Water Act. These projections are used together with estimated costs and other information to assess the effects of the effluent control requirements on future industry conditions.

The baseline projections in this report provide a general point of reference for the analysis and are not intended to be a comprehensive, authoritative forecast of future industry conditions. These projections provide a plausible picture of future developments, and thus can be used as a benchmark for comparison. Although minor changes to the baseline may result from a more comprehensive treatment of forecasting techniques, they are not likely to significantly alter the study's overall conclusions regarding the extent of the economic impacts of the effluent guidelines.

The basic approach followed in developing the projections begins with a forecast of demand-related factors. Then, using the resulting initial volume estimates, industry supply factors are assessed to determine if there would be any significant changes in the level of capital requirements and anticipated growth in terms of the number of plants and quantity of production.

4.1 DEMAND-RELATED FACTORS

The primary reason for beginning the baseline projections with the demand analysis is based on the hypothesis that the aluminum industry supply factors will adjust to demand conditions. This results from two factors: (1) the aluminum industry group is a small proportion of the total economic activity in the U.S. and is, therefore, more likely to react to general trends rather than influence them; and (2) the demand for aluminum products is a derived demand, depending on the sales and use of thousands of other products that use aluminum, such as automobiles, refrigerators, air conditioners, and other electrical products.

Demand forecasting is an inexact discipline, with considerable dependence on individual judgment and simplifying assumptions. Each forecasting technique has its own particular advantages and disadvantages, which could result in different types of errors. The requirement for this study is not a precise, comprehensive forecast of industry conditions; instead this study requires an approximate estimate of the likely trends in quantity of aluminum forming products demanded. To make this approximation, a regression analysis was performed.

Regression analysis is a statistical technique used to summarize the relationship between the fluctuations in the value of a variable and that of the variables that are believed to cause these fluctuations, or explanatory variables. It is an empirical tool that is extensively used in business and economic analyses to explain relationships between variables and to predict market phenomena. In demand analysis this technique is used to relate changes in quantities of a product demanded to the level of activity in economic entities that use the product and to product prices and prices of substitute and complementary products. Once such a relationship is established, a forecast of the future demand conditions can be made based on exogenous predictions of the explanatory variables.

In this analysis, it is assumed that there is a causative flow of activity that runs from macroeconomic activity to activity in industries that produce investment and consumer goods to activity in industries that produce fabricated metal products to the aluminum forming industry itself. Thus, activity variables were sought for which exogenous forecasts are readily available from such sources as the Wharton EFA model, Predicasts Inc., and the Data Resources Inc. model. These activity variables consisted of general economic indicators, such as the Federal Reserve Board industrial production indexes, GNP, and personal consumption expenditures. The price of aluminum products is expressed relative to other metal products. The prices of substitute and complementary products were tested, but found to be statistically insignificant.

After testing a variety of functional forms, different estimation time periods and price variables, a dynamic model of the log-log form employing a Koyck distributed lag structure was selected for use in the baseline forecast. The explanatory variables, time period, structure, and statistical properties of this model are described in Appendix D. The projections derived from the model are reported in Table 4-1.

The demand for aluminum forming products is found to be highly cyclical, primarily because they are used in the manufacture of durable goods, the demand for which is highly cyclical. The projections shown in Table 4-1 indicate a trend ranging from almost no growth for the forging, and wire and cable product groups to five percent annually for the sheet and plate group.

4.2 SUPPLY FACTORS

The primary supply factors of interest are the number of industry establishments, prices, profits and industry locations.

4.2.1 Number of Industry Establishments in 1990

This subsection addresses the number of baseline closures and new sources that might be expected during the 1980s. The above forecasted increase in demand through the 1980s can be supplied by (a) increasing capacity utilization at current plants, (b) modifying current plants to increase their capacity, (c) constructing new plants, and (d) increasing imports. Since aggregate industry output is expected to increase, baseline closures would not likely result from economic trend.

During the 1980-82 period, capacity utilization at aluminum mill products plants has been low. A significant portion of the increased demand during the 1980s can be met by increasing operating levels at existing facilities. Therefore it is unlikely that a substantial number of new plants will be opened during the 1980s. There may, however, be modifications at existing plants. There is insufficient information to determine the number of modifications that will be substantial enough to be subject to new source standards.

TABLE 4-1

PROJECTIONS OF DOMESTIC CONSUMPTION OF ALUMINUM FORMING PRODUCTS

Year	Sheet and Plate	Foil	Tube and Extruded Shapes	Rod, Bar and Bare Wire	Conductor Wire and Cable	Forgings
			(Millions of Pounds)			
1974	5314	745	2287	410	980	109
1975	3882	606	1549	257	644	79
1976	5376	769	2043	376	598	80
1977	5821	803	2286	206	671	100
1978	6488	886	2474	390	754	116
1979	6209	884	2390	409	815	123
1980	5551	802	2178	379	734	104
1981	5756	842	2082	324	637	106
Projected						
1985	7427	972	2288	353	758	106
1986	8654	1085	2411	396	762	106
1990	9643	1188	2506	440	765	106
			(Percentage Growth)			
1970-1980	55.8	37.6	24.2	66.2	-0.9	55.2
1975-1980	43.0	32.3	40.6	47.5	14.0	31.6
1979-1980	-10.6	-9.3	-8.9	-7.3	-9.9	-15.4
1980-1981	3.7	5.0	-4.4	-14.5	-13.2	1.9
Projected						
1981-1985	29.0	15.4	9.9	9.0	19.0	0
1985-1990	29.8	22.2	9.5	24.6	0.9	0

Source: JRB Associates estimates

As discussed in Section 3.8, the U.S. has always been a net exporter of aluminum mill products and time series data does not indicate any shift in this situation. Moreover, imports and exports are a small proportion of total domestic consumption. However, as history indicates, periodic strains on domestic capacity may cause aluminum mill product users to turn to foreign suppliers.

For the above reasons, there is no reason to expect significant changes in the number of aluminum mill products plants during the 1980s.

4.2.2 Product Price and Profitability

If the price of aluminum forming products were to change substantially relative to those of competing products, then the aforementioned demand relationships may change. In addition, changes in industry profitability will change the industry's ability to finance the pollution control equipment. To account for these possible situations, a review of the factors affecting costs was conducted to determine the likelihood of such changes during the 1980s.

The primary factors of production in this industry are raw materials, energy, capital, and labor. Although energy costs are potentially volatile, it is believed that they would not increase more than the general price levels (e.g., GNP deflator) in the future. There is currently an over supply of oil in the World today which is placing a downward pressure on the price of oil and energy in general. This downward pressure on oil prices is expected to last during the 1980's as OPEC continues to lose its market share and the concomittant power to maintain artificially high prices. Labor, capital and other costs are expected to increase at the same rate as those of other industries. Because the industry's cost structure and market structure is not expected to change significantly during the 1980s, there is no reason to expect significant changes in the profitability of aluminum forming.

4.3 SUMMARY OF BASELINE CONDITIONS

The following summarizes the major conclusions of the baseline analysis:

- Industry demand for aluminum forming products will grow moderately.
- Prices of aluminum forming products will increase at about the same rate as those in the general economy.
- The number of establishments will not change significantly during the 1980s and there will be no baseline closures.
- Insufficient information is available to reliably estimate changes in profitability measures for the industry. However, no reason was found to expect it to change and the economic analysis was conducted under the assumptions that profit rates remain at normal levels.

These conclusions are used in Chapter 6, in conjunction with other information, to estimate the likely economic impacts to result from the regulations.

5. COST OF COMPLIANCE

5.1 OVERVIEW

The recommended water treatment control systems, costs, and effluent limitations for the aluminum forming category are enumerated in the *Development Document for Effluent Limitations Guidelines and Standards for the Aluminum Forming Point Source Category*, cited earlier. That document identifies various characteristics of the industry, including the manufacturing processes; products manufactured; volume of output; raw waste characteristics; supply, volume, and discharge destination of water used in the production processes; sources of wastewaters; and the constituents of wastewaters. Using the data in the Development Document, pollutant parameters requiring limitations or standards of performance were selected by EPA.

The EPA Development Document also identifies and assesses the range of control and treatment technologies within each industry subcategory. The assessment procedure involved an evaluation of both in-plant and end-of-pipe technologies that could be designed for each subcategory. Information about these technologies for existing surface water industrial dischargers was evaluated to determine the effluent limitations required for the Best Practical Control Technology Currently Available (BPT), and the Best Available Technology Economically Achievable (BAT). A similar evaluation was performed for existing dischargers to publicly owned treatment works (POTWs) to develop Pretreatment Standards for Existing Sources (PSES). Finally, New Source Performance Standards (NSPS) and Pretreatment Standards for New Sources (PSNS) were developed. The identified technologies were analyzed to estimate cost and performance of each. Cost data were expressed in terms of investment, operating and maintenance costs, depreciation, and interest expense. Pollution characteristics were expressed in terms of volume of wastewater produced per unit of mass of product (gal/ton or l/kkg) for each subcategory.

5.2 POLLUTANT PARAMETERS

The selection of pollution parameters for the application of effluent limitations guidelines and standards was primarily based on a review of laboratory analyses of wastewater samples from 20 aluminum plants and responses to a mail survey submitted to 580 firms[1/]. This information was used to estimate the concentration of each of the 129 priority pollutants as well as the "conventional and non-conventional pollutants" in the study of water pollution. The specific approach to selecting pollutant parameters is presented in Sections V, VI, IX, X, XI and XII of the Development Document.

5.3 CONTROL AND TREATMENT TECHNOLOGIES

Based on the analysis of the significant pollutant parameters and treatment in place in the aluminum forming category, EPA identified 6 treatment technologies that are most applicable for the reduction of the selected pollutants. These treatment technologies are described in detail in the Development Document and are listed below:

- Treatment Option 1: Hexavalent chromium reduction, cyanide removal and chemical emulsion breaking (where applicable); oil skimming; chemical precipitation; sedimentation
- Treatment Option 2: Option 1 plus flow reduction by recycle, and counter-current rinsing
- Treatment Option 3: Option 2 plus polishing filtration after settling
- Treatment Option 4: Option 2 plus thermal emulsion-breaking to achieve zero discharge of emulsified lubricants
- Treatment Option 5: Option 4 plus polishing filtration
- Treatment Option 6: Option 5 plus granular activated carbon as a preliminary treatment step.

EPA evaluation of Treatment Option 6 concluded that this technology would provide only minimal incremental removal of pollutants at significantly higher costs than the other options. For this reason, Treatment Option 6 was eliminated from consideration. Furthermore, Treatment Options 4 and 5 are not being considered for promulgation. Consequently, the economic impact analysis concentrated on Treatment Options 1, 2 and 3 only.

[1/] 279 responses applicable to the aluminum forming category were returned.

5.4 COMPLIANCE COST ESTIMATES

5.4.1 Cost Factors, Adjustments, and Assumptions

In developing the compliance cost estimates, a number of critical factors were estimated, and adjustments and assumptions were made by EPA. These assumptions, as outlined in the Development Document, are as follows:

- All costs are expressed in January, 1978 dollars.
- The cost of electricity used is 4.0 cents per kilowatt hour, which is based on the average value reported in the industry survey.
- Capital costs are amortized at 10 years and 12 percent interest. The annual cost of depreciation was calculated on a straight line basis over a 10-year period.
- Subsidiary costs associated with system construction are included in the system cost estimates. These include:
    - major and auxiliary equipment
    - piping and pumping
    - shipping
    - sitework
    - installation
    - contractors' fees
    - electrical and instrumentation
    - enclosure
    - contingencies
    - engineering, and
    - yard piping.
- Sludge disposal costs are included in the cost estimates, where applicable.
- The cost of land has not been included in the cost estimates.
- Where a batch, continuous, or haul-away treatment system was possible, the system with the lowest life cycle cost (over a 10-year period) was selected for presentation in the system cost table.
- A labor rate of 20 dollars per man-hour, including fringe benefits and plant overhead was used to convert the man-hour requirements into annual cost.

5.4.2 Compliance Costs of Existing Sources

The economic analysis covers 271 aluminum forming plants.[1/] However, the compliance costs do not affect 140 "zero discharge" plants--i.e.,plants at which no process wastewater is generated. Those affected are 131 plants discharging wastes: 59 plants discharging to surface waters (direct dischargers) and 72 discharging to publicly owned treatment works (indirect dischargers). Plant-specific compliance costs estimates are available for 123 plants (57 direct and 66 indirect), and these are extrapolated to estimate the costs for all 131 dischargers in the industry.

Table 5-1 shows that total industry annual compliance costs range between $27.4 million for Treatment Option 1 and $33.8 million for Treatment Option 3 in 1978 dollars. Capital investment requirements vary between $45.9 million for Treatment Option 1 and $63.8 million for Treatment Option 3.

Table 5-2 and 5-3 summarize the compliance costs for direct and indirect dischargers respectively. The selected option for both the direct and indirect dischargers is Option 2. These tables show that the costs of the regulations as measured by the annual compliance cost to revenue ratios are higher for the indirect dischargers than for the direct dischargers. This is primarily because direct dischargers generally have more treatment equipment already in place.

5.4.3 Compliance Cost of New Sources

Compliance costs of new source normal plants are estimated for treatment options 1, 2, and 3. Table 5-4 summarizes the compliance cost estimates of these alternatives by each technical subcategory. The costs apply to existing facilities that are substantially modified and to greenfield (new) plants. Section 8 of the Development Document explains in detail the composition of the aluminum forming normal plants.

[1/] The 1978 EPA survey identified 279 plants in operation in 1977. Since then eight have either shut down or discontinued aluminum forming production.

TABLE 5-1
TOTAL COSTS BY INDUSTRY SEGMENT, ALUMINUM FORMING INDUSTRY
(1978 dollars)

Industry Segment	Number of Plants	Total Production	Value of Shipments	Option 1 Annual Cost	Option 1 Capital Investment	Option 2 Annual Cost	Option 2 Capital Investment	Option 3 Annual Cost	Option 3 Capital Investment
		mil lbs	$mil	$ Thousands					
Sheet, Strip & Plate	21	3,080	2,970	3,816	6,651	6,028	13,015	7,008	16,543
Foil	6	179	203	0	0	0	0	0	0
Tube and Extruded Shapes	158	2,259	2,198	13,390	20,464	14,911	23,287	15,761	25,727
Wire	44	377	408	750	1,385	750	1,385	792	1,528
SFE a/	20	3,511	2,963	5,365	8,885	5,470	9,132	5,948	10,537
RBW b/	6	485	588	2,024	4,160	2,024	4,160	2,122	4,549
Forging	16	99	282	2,043	4,322	2,106	4,543	2,218	4,962
Total	271	9,990	9,612	27,388	45,867	31,289	55,522	33,849	63,846

a/ Sheet, Strip & Plate; Foil; Tube and Extruded Shapes

b/ Rod, Bar, & Bare Wire; Conductor Wire and Cable

Source: JRB Associates estimates.

TABLE 5-2. COMPLIANCE COSTS FOR DIRECT DISCHARGERS
(1978 dollars)

				Option 1			Option 2			Option 3		
Industry Segment	Number of Plants	Total Production	Value of Shipments	Annual Cost	Capital Investment	ACC[d/] / REV	Annual Cost	Capital Investment	ACC[d/] / REV	Annual Cost	Capital Investment	ACC[d/] / REV
		mil lbs	$mil	$ Thousands		%	$ Thousands		%	$ Thousands		%
Sheet, Strip & Plate	9	a/	a/	2,349	4,063	a/	4,561	10,427	a/	5,373	13,472	a/
Foil	0	0	0	0	0	0	0	0	0	0	0	0
Tube & Extruded Shapes	36	975	971	6,496	11,766	.67	7,177	13,268	.74	7,654	14,697	.79
Wire	1	a/	a/	115	263	a/	115	263	a/	124	295	a/
SFE[b/]	8	2,626	2,162	4,836	7,835	.22	4,860	7,815	.22	5,304	9,094	.25
RBW[c/]	5	a/	a/	2,024	4,160	a/	2,024	4,160	a/	2,122	4,549	a/
Forging	0	0	0	0	0	0	0	0	0	0	0	0
Total	59	6,713	6,417	15,820	28,087	.25	18,737	35,933	.29	20,577	42,107	.32

[a/] Withheld to avoid disclosure of confidential information

[b/] Sheet, Strip & Plate; Foil; Tube and Extruded Shapes

[c/] Rod, Bar & Bare Wire; Conductor Wire and Cable

[d/] Annual Compliance Cost/Revenue

Source: JRB Associates estimates.

TABLE 5-3
COMPLIANCE COSTS FOR INDIRECT DISCHARGERS
(1978 dollars)

Industry Segment	Number of Plants	Total Production	Value of Shipments	Option 1			Option 2			Option 3		
				Annual Cost	Capital Investment	ACC[d]/ REV	Annual Cost	Capital Investment	ACC[d]/ REV	Annual Cost	Capital Investment	ACC[d]/ REV
		mil lbs	$mil	$ Thousands		%	$ Thousands		%	$ Thousands		%
Sheet, Strip & Plate	2	a/	a/	1,467	2,588	a/	1,467	2,588	a/	1,635	3,070	a/
Foil	0	0	0	0	0	0	0	0	0	0	0	0
Tube & Extruded Shapes	46	635	564	6,895	8,698	1.22	7,735	10,018	1.37	8,107	11,029	1.44
Wire	8	a/	a/	635	1,121	a/	635	1,121	a/	668	1,233	a/
SFE[b]/	4	209	133	530	1,050	.40	610	1,317	.46	644	1,444	.48
RBW[c]/	0	0	0	0	0	0	0	0	0	0	0	0
Forging	12	95	274	2,043	4,322	.75	2,106	4,543	.77	2,218	4,962	.81
Total	72	1,276	1,220	11,570	17,779	.95	12,553	19,587	1.03	13,272	21,738	1.09

[a]/Withheld to avoid disclosure of confidential information

[b]/Sheet Strip & Plate; Foil; Tube and Extruded Shapes

[c]/Rod, Bar & Bare Wire; Conductor Wire and Cable

[d]/Annual Compliance Cost/Revenue

Source: JRB Associates estimates.

TABLE 5-4. NEW SOURCE COMPLIANCE COSTS
(1978 Dollars)

	Rolling With Neat Oils	Rolling With Emulsions	Extrusion	Forging	Drawing With Neat Oils	Drawing With Emulsions
Plant Annual Production (million lbs)	366.8	330.1	42.2	10.5	35.7	15.2
Plant Revenues (million dollars)	356[a]	320[a]	41[b]	30[c]	41[d]	18[d]
Capital Investment						
Option 1 - $000	715.7	1,017.7	412.0	387.1	382.7	313.1
- % of Revenues	0.20	0.31	1.00	1.29	0.94	1.74
Option 2 - $000	634.6	1,025.2	409.5	308.3	325.9	281.2
- % of Revenues	0.18	0.31	1.00	1.03	0.79	1.56
Option 3 - $000	660.5	1,100.6	447.6	328.5	344.6	299.8
- % of Revenues	0.18	0.33	1.09	1.10	0.84	1.67
Annual Costs						
Option 1 - $000	793.1	914.4	243.6	254.2	256.1	162.9
- % of Revenues	0.22	0.28	0.59	0.85	0.62	0.91
Option 2 - $000	699.7	918.0	229.5	205.1	218.3	154.5
- % of Revenues	0.19	0.28	0.56	0.68	0.53	0.86
Option 3 - $000	717.1	978.9	252.6	216.1	229.8	166.0
- % of Revenues	0.20	0.30	0.62	0.72	0.56	0.92

[a] Assume $0.97/lb (average price of sheet, plate and foil).

[b] Assume $0.97/lb (average price of tube and extruded products).

[c] Assume $2.85/lb (average price of forging products).

[d] Assume $1.16/lb (average price of rod, bare wire and conductor wire).

Source: Environmental Protection Agency

6. ECONOMIC IMPACT ANALYSIS

This section provides an assessment of the economic impacts which are likely to occur as a result of the costs of the effluent treatment technologies described in Chapter 5. It is based upon an examination of the estimated compliance costs and other economic, technical, and financial characteristics of 263 plants for which compliance costs have been estimated. Because of lack of data, compliance costs are not estimated for eight plants (all extrusion plants) and they are not included in this analysis. The analytical methodology used is described in Chapter 2. The primary economic impacts discussed include changes in industry profitability, plant closures, substitution effects, changes in employment, shifts in imports and exports, and industry structure effects.

The 263 plant sample represents about 97 percent of the plants in the industry, and contains a wide range of both large and small plants. Furthermore, this sample includes 123 (94 percent) of the 131 known discharging plants in the industry. Therefore, the sample appears to adequately represent the industry for the purposes of this study.

6.1 BASELINE CONDITIONS

As presented in Chapters 3 and 4 of this report the following factors point to a favorable baseline projection:

- The demand for aluminum forming products, although cyclical, has exhibited an upward trend,
- A continuation of this growth pattern is projected through the 1980s,
- The number of plants in the industry has been generally constant through the 1970s.

There is no evidence of general industry conditions that would lead to attrition in the baseline number of plants,[1] volume of production, or number of employees in the industry.

6.2 PRICE AND QUANTITY CHANGES

Table 6-1 shows the industry-wide price increases and the resulting quantity changes for each compliance option estimated from the pricing strategy model described in Chapter 2. The price increases are generally small, not exceeding one percent for any option. Similarly, the quantity changes are also very small. The percentage changes in price and quantity are small in comparison to the forecasted growth rate of the aluminum forming industry. The small changes in quantity demanded suggest that the major impacts, to the extent they exist, will be intra-industry. That is, the degree to which the unit compliance costs are unequally distributed across the industry will determine the extent of the impacts.

After the industry-wide price and quantity adjustments are determined, the individual plant impacts are examined. The following sections focus on these impacts.

6.3 MAGNITUDE OF COMPLIANCE COSTS

To evaluate the magnitude of the costs of the regulations, the ratios of annual compliance costs to revenues (ACC/R) and compliance capital investment to revenues (CCI/R) ratios are calculated for each plant. Tables 6-2 and 6-3 present the distribution of the ACC/R and CCI/R ratios respectively, for the 263 aluminum forming sample plants. These tables indicate that the financial burden of the regulations is estimated to be greatest for the extrusion, wire drawing and forging plants. A detailed impact analysis which determines potential plant closures and other impacts is presented in the following sections.

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[1] Although eight plants have been identified to have either closed down or discontinued their aluminum forming operations since 1977, these instances are due to special individual market conditions and/or corporate marketing strategy and are not representative of the general industry growth pattern.

TABLE 6-1

ANTICIPATED INDUSTRY PRODUCT PRICE AND PRODUCTION CHANGES (in percent)

Product Group	Option 1		Option 2		Option 3	
	dP/P	dQ/Q	dP/P	dQ/Q	dP/P	dQ/Q
Sheet & Plate	0.19	-0.11	0.24	-0.14	0.27	-0.16
Foil	0	0	0	0	0	0
Tube & Extruded Shapes	0.64	-0.58	0.71	-0.64	0.75	-0.68
Rod, Bar, and Bare Wire	0.36	-0.29	0.36	-0.29	0.38	-0.30
Conductor Wire and Cable	0.25	-0.29	0.26	-0.29	0.28	-0.31
Forging	0.76	-0.30	0.79	-0.32	0.83	-0.33
Sheet and Plate/ Foil/Tube & Extruded Shapes (SFE)[a]	0.13	-0.07	0.17	-0.09	0.19	-0.10
Rod, Bar, and Bare Wire/Conductor Wire and Cable (RBW)[b]	0.31	-0.31	0.31	-0.31	0.33	-0.33

dP/P = change in price ÷ pre-compliance price (percent)

dQ/Q = change in quantity ÷ pre-compliance quantity (percent)

[a] Weighted average of Sheet and Plate (70 percent) and foil (30 percent) product groups.

[b] Weighted average of Rod, Bar and Bare Wire (50 percent) and Conductor Wire and Cable (50 percent) product groups.

Source: JRB Associates estimates.

TABLE 6-2. DISTRIBUTION OF ANNUAL COMPLIANCE COST TO REVENUE RATIOS

Product/Group Option	Number of Plants in Sample	Number of Dischargers	Number of Sample Discharging Plants with ACC/R (in percent)				
			0-0.5	0.5-1	1-2	2-5	>5
Sheet & Plate	21	11					
Option 1			8	2	1	0	0
Option 2			8	2	1	0	0
Option 3			7	2	2	0	0
Foil	6	0					
Option 1			0	0	0	0	0
Option 2			0	0	0	0	0
Option 3			0	0	0	0	0
Tube and Extruded Shapes	150	74					
Option 1			12	29	23	9	1
Option 2			9	23	32	9	1
Option 3			8	18	37	10	1
Conductor Wire and Cable	44	9					
Option 1			4	1	3	1	0
Option 2			4	1	3	1	0
Option 3			4	1	3	1	0
SFE[a]	20	12					
Option 1			12	0	0	0	0
Option 2			11	1	0	0	0
Option 3			11	1	0	0	0
RBW[b]	6	5					
Option 1			3	0	2	0	0
Option 2			3	0	2	0	0
Option 3			3	0	2	0	0
Forging	16	12					
Option 1			1	4	3	3	1
Option 2			1	4	3	3	1
Option 3			1	4	3	3	1
Total Sample	263	123					
Option 1			40	36	32	13	2
Option 2			36	31	41	13	2
Option 3			34	26	47	14	2

[a] Sheet & Plate/Foil/Tube and Extruded Shapes

[b] Rod, Bar & Bare Wire/Conductor Wire & Cable

Source: JRB Associates estimates.

TABLE 6-3. DISTRIBUTION OF COMPLIANCE CAPITAL INVESTMENT TO REVENUE RATIOS

Product Group/ Option	Number of Plants in Sample	Number of Dischargers	Number of Sample Discharging Plants with CCI/R (in percent)				
			0-1	1-2	2-5	5-10	>10
Sheet & Plate	21	11					
Option 1			8	2	1	0	0
Option 2			7	3	1	0	0
Option 3			7	2	2	0	0
Foil	6	0					
Option 1			0	0	0	0	0
Option 2			0	0	0	0	0
Option 3			0	0	0	0	0
Tube and Extruded Shapes	150	74					
Option 1			30	20	23	1	0
Option 2			26	17	29	2	0
Option 3			25	15	32	2	0
Conductor Wire And Cable	44	9					
Option 1			5	2	2	0	0
Option 2			5	2	2	0	0
Option 3			5	0	4	0	0
SFE[a]	20	12					
Option 1			11	1	0	0	0
Option 2			10	2	0	0	0
Option 3			9	3	0	0	0
RBW[b]	6	5					
Option 1			3	0	2	0	0
Option 2			3	0	2	0	0
Option 3			3	0	2	0	0
Forging	16	12					
Option 1			1	4	7	0	0
Option 2			1	3	7	1	0
Option 3			1	3	6	1	1
Total Sample	263	123					
Option 1			58	29	35	1	0
Option 2			52	27	41	3	0
Option 3			50	23	46	4	0

[a] Sheet & Plate/Foil/Tube and Extruded Shapes

[b] Rod, Bar & Bare Wire/Conductor Wire & Cable

Source: JRB Associates estimates.

6.4 PROFIT IMPACT ANALYSIS

The assessment of the impact of compliance on plant profitability (ROI) is based on the algorithms shown in Chapter 2 combined with the parameters in Table 6-4. These parameters represent average industry financial ratios. These ratios are imputed to each plant because plant-specific baseline financial characteristics (e.g., plant profit margin, assets value, variable and fixed costs of production) are not available. The differences in profitability among the various product groups are due primarily to different assets to sales ratios across product groups. Appendix C describes the methodology for estimating the baseline values for the key financial variables.

After compliance ROIs (before taxes) were calculated for each of the 263 sample plants. Table 6-5 presents the distribution of plant changes in ROI as the result of the regulations. The regulations seem to affect the extrusion, wire drawing, and forging plants most as 16 plants (11 extrusion, 2 wire, and 3 forging) have ROI reductions greater than 3 percent at Treatment Option 2.

Plants with post-compliance ROI less than 2.7 percent are considered to be "potential" plant closures. The 2.7 percent ROI threshold level (before taxes) is based on the assumption that plants cannot continue to operate as viable concerns if they are unable to generate for the owners/stockholders 8 percent after-tax return on the liquidation value of their investments (i.e. return on liquidation value equity). Appendix B describes in detail the methodology for estimating the ROI threshold level.

Three extrusion plants, one wire and cable plant, and one forging plant, a total of 5 plants, have estimated ROIs below the critical value at all three treatment options. Table 6-6 summarizes the results of the profit impact analysis.

6.5 CAPITAL REQUIREMENTS ANALYSIS

As presented in Chapter 2, the "fixed charge coverage" ratio was used to evaluate a firm's ability to raise the capital necessary to install the proposed pollution control systems. The "fixed charge coverage" ratio is

TABLE 6-4. BASELINE CHARACTERISTICS OF ALUMINUM FORMING INDUSTRY

Product Group	Price Elasticity	Before Tax Return on Sales (%)	Ratio of Variable Cost to Total Cost	Ratio of Assets to Revenues
Sheet and Plate	-.6	5.4	.80	.68
Foil	-.4	5.4	.80	.68
Tube and Extruded Shapes	-.9	4.2	.85	.53
Rod, Bar, and Bare Wire	-.8	4.1	.85	.53
Conductor Wire and Cable	-1.1	4 2	.85	.53
Forging	-.4	5.2	.85	.66
Sheet and Plate/ Foil/Tube and Extruded Shapes (SFE)	-.5[a/]	5.4[a/]	.80[a/]	.68[a/]
Rod, Bar, and Bare Wire/ Conductor Wire and Cable (RBW)	-1.0[b/]	4.1[b/]	.85[b/]	.53[b/]

[a/] Weighted average of Sheet and Plate; Foil; and Tube and Extruded Shapes product groups.

[b/] Weighted average of Rod, Bar and Bare Wire; and Conductor Wire and Cable product groups.

Source: *Census of Manufactures*, Federal Trade Commission's *Quarterly Financial Report for Manufacturing, Mining and Trade Corporations*, company annual reports and contact with industry personnel.

TABLE 6-5., DISTRIBUTION OF CHANGE IN ROI

Product Group/ Option	Number of Plants in Sample	Number of Dis- chargers	Number of Sample Discharging Plants with ROI Reduction (in percent)				
			<1	1-2	2-3	3-4	>4
Sheet & Plate	21	11					
Option 1			9	1	1	0	0
Option 2			9	1	1	0	0
Option 3			8	2	1	0	0
Foil	6	0					
Option 1			0	0	0	0	0
Option 2			0	0	0	0	0
Option 3			0	0	0	0	0
Tube and Extruded Shapes	150	74					
Option 1			33	24	8	2	7
Option 2			27	27	9	4	7
Option 3			24	26	13	3	8
Conductor Wire and Cable	44	9					
Option 1			5	1	1	1	1
Option 2			5	1	1	1	1
Option 3			5	1	1	1	1
SFE[a/]	20	12					
Option 1			12	0	0	0	0
Option 2			12	0	0	0	0
Option 3			12	0	0	0	0
RBW[b/]	6	5					
Option 1			3	1	1	0	0
Option 2			3	1	1	0	0
Option 3			3	1	1	0	0
Forging	16	12					
Option 1			5	2	2	2	1
Option 2			6	2	1	2	1
Option 3			5	2	2	1	2
Total Sample	263	123					
Option 1			67	29	13	5	9
Option 2			62	32	13	7	9
Option 3			57	32	18	5	11

[a/] Sheet & Plate/Foil/Tube and Extruded Shapes

[b/] Rod, Bar & Bare Wire/Conductor Wire & Cable

Source: JRB Associates estimates.

TABLE 6-6. SUMMARY OF PROFIT IMPACT ANALYSIS

Product Group	Baseline ROI (%)	ROI Threshold Value (%)	Number of Plants in Sample	Number of Dischargers	Number of High Impact Plants		
					Option 1	Option 2	Option 3
Sheet and Plate	7.9	2.7	21	11	0	0	0
Foil	7.9	2.7	6	0	0	0	0
Tube and Extruded Shapes	7.9	2.7	150	74	3	3	3
Conductor Wire and Cable	7.9	2.7	44	9	1	1	1
Sheet and Plate/ Foil/Tube and Extruded Shape (SFE)	7.9	2.7	20	12	0	0	0
Rod, Bar, and Bare Wire/ Conductor Wire and Cable (RBW)	7.9	2.7	6	5	0	0	0
Forging	7.9	2.7	16	12	1	1	1
Total			263	123	5	5	5

Source: JRB Associates estimates.

defined as the ratio of earnings before interest and taxes to all fixed charge obligations (i.e., interest payments). This ratio is often used by lenders to evaluate firms' ability to incur additional debt. In this analysis, the ratio is applied to individual plants. Firms or plants with fixed charge coverage ratios greater than 2 are generally considered solvent and will not have much difficulty obtaining additional loans.

Table 6-7 presents the results of the capital availability analysis. Five plants (3 extrusion, 1 wire, and 1 forging) have coverage ratios less than 2. These 5 plants are the same plants that failed the profit impact test described in Section 6.4.

6.6 PLANT CLOSURE ANALYSIS

While financial parameters are the paramount determinants of plant-closures, non-financial factors are also important and, may dominate the decision process. Therefore, the plant closure decision, like most investment decisions, ultimately involves managerial judgment. For this reason, decision makers consider a number of other factors, in addition to financial variables. Some of these other factors are market growth potential, contribution to total firm's product line, diversification, integration, intra-industry competition, and substitution potential for the products.

In this analysis, the relevant investment decision factors are combined in a summary table to model the investment decision-making process, thereby facilitating estimates of plant closures. This information is shown in Table 6-8 for the five highly impacted aluminum forming plants in the sample identified in the above profit impact and capital requirements analyses. The Table shows that all five plants are projected to have high probability of closure at each treatment option.

Table 6-9 summarizes the results of the plant closure analysis. Other impacts of the regulations such as employment, community and regional effects, substitution effects, foreign trade impacts, and industry structure effects are examined in Section 6.7.

TABLE 6-7. SUMMARY OF CAPITAL AVAILABILITY ANALYSIS

Product Group	Number of Plants in Sample	Number of Dischargers	Plants with FCC Ratio* Less Than 2		
			Option 1	Option 2	Option 3
Sheet and Plate	21	11	0	0	0
Foil	6	0	0	0	0
Tube and Extruded Shapes	150	74	3	3	3
Conductor Wire and Cable	44	9	1	1	1
Sheet and Plate/Foil/ Tube and Extruded Shapes (SFE)	20	12	0	0	0
Rod, Bar, and Bare Wire/Conductor Wire and Cable (RBW)	6	5	0	0	0
Forging	16	12	1	1	1
Total Sample	263	123	5	5	5

*FCC Ratio: Fixed Charge Coverage Ratio.

Source: JRB Associate estimates.

TABLE 6-8. SUMMARY OF POTENTIAL FOR CLOSURES DUE TO REGULATION

Product Group/Plant	Annual Production (mil lbs)	Market Share	Industry Competition	Firm Diversification/ Integration	Treatment Option	After Compliance ROI (%)	CCI to Revenues (%)	FCC Ratio	Ability to Raise Capital	Potential for Closure
Tube and Extruded Shapes										
E1	10-15	Medium	High	Low	1	-2.1	0.3	0.2	Poor	High
					2	-2.0	0.3	0.2	Poor	High
					3	-2.2	0.5	0.1	Poor	High
E2	10-15	Medium	High	Low	1	0.1	0.2	1.0	Poor	High
					2	-0.3	0.8	0.9	Poor	High
					3	-0.5	1.0	0.8	Poor	High
E3	1-3	Small	High	Low	1	0.8	2.5	1.3	Poor	High
					2	0.9	2.5	1.3	Poor	High
					3	0.7	2.5	1.2	Poor	High
Conductor Wire and Cable										
W1	5-7	Small	High	High	1	2.6	1.5	2.0	Good	Moderate[a/]
					2	2.6	1.5	2.0	Good	Moderate[a/]
					3	2.2	2.3	1.8	Moderate	High[a/]
Forgings										
F1	<1	Small	Moderate	Moderate	1	0.2	3.1	1.1	Poor	High[a/]
					2	-2.5	9.8	0.2	Poor	High[a/]
					3	-2.9	10.6	0.1	Poor	High[a/]

[a/] Line closure

JRB Associates estimates

TABLE 6-9. SUMMARY OF PLANT CLOSURE ANALYSIS (ALL TREATMENT OPTIONS)

		Discharging Plants	
	Total	Direct	Indirect
Tube and Extruded Shapes			
Number of Plants	82	36	46
Number of Closures	3	2	1
Employment Losses	258	221	37
Annual Production of Closed Facilities (million lbs)	26	13	13
Market Share of Closed Facilities (%)	1.2	0.6	0.6
Conductor Wire and Cable			
Number of Plants	9	1	8
Number of Closures[a]	1	0	1
Employment Losses	203	0	203
Annual Production of Closed Facilities (million lbs)	6	0	6
Market Share of Closed Facilities (%)	1.0	0	1.0
Forging			
Number of Plants	12	0	12
Number of Closures[a]	1	0	1
Employment Losses	36	0	36
Annual Production of Closed Facilities (million lbs)	<1	0	<1
Market Share of Closed Facilities (%)	<0.1	0	<0.1

[a] These projected closures are line closures; the plants also manufacture other products in addition to aluminum forming products.

Source: JRB Associates estimates.

A sensitivity analysis assuming a lower baseline return on assets (6.4 percent instead of 7.9 percent) was performed for the integrated producers. The results of this sensitivity analysis show no additional plant closures (see Section 8.3.1).

6.7 OTHER IMPACTS

6.7.1 Employment, Community, and Regional Effects

As shown in Table 6-9, there is potential for five plant closures at all three treatment options involving a loss of about 500 jobs. The plants projected to close are generally located in large metropolitan/industrial areas and do not account for a significant portion of community employment; hence there are no significant community or regional impacts likely.

Meanwhile, the industry price increases due to regulations result in less than 0.8 percent reduction in quantity of aluminum forming products demanded (see Table 6-1). Since most aluminum forming plants have less than 500 employees (see Table 3-2), such small quantity reduction would affect on the average less than 4 employees per plant. Such small employment effect will not have substantial community or regional impacts.

6.7.2 Substitution Effects

The price increases due to regulatory compliance costs will frequently lead to substitution by other products and materials which, in turn, results in a decrease in the quantity of product demanded.

However, the compliance costs of the regulations for the aluminum forming industry are relatively small and the price increases due to compliance are projected to be less than one percent for all industry segments. As shown in Table 6-1, such low price increases will result in changes in quantity demanded ranging from zero percent for some product groups to 0.8 percent for others. Thus, the regulations will cause insignificant shifts to the use of other materials.

6.7.3 Foreign Trade Impacts

As described in Chapter 3, foreign trade in some segments of the aluminum forming industry increased in recent years. If there is a significant price effect from the regulations, the U.S. competitive position could be damaged. However, as shown in Table 6-1, the price increases estimated to result from the regulations are quite small, amounting to fractions of a percent for all product groups. Price increases of this magnitude would not be large enough to change the trading pattern.

6.7.4 Industry Structure Effects

As discussed in Section 6.6, it is estimated that a total of 3 extrusion plants, 1 wire drawing plant, and 1 forging plant are projected to close at all treatment options. The wire drawing and forging closures are operations with less than 6 million pounds annual production and account for a fraction of a percent of the industry total production; their closures, therefore, will not affect the structure of these industry groups.

The 3 extrusion plants projected to close at Option 2 include both small and large plants. Total production of these closed facilities accounts for about 1 percent of industry output, and their closures are not expected to significantly change the industry structure.

6.8 NEW SOURCE IMPACTS

Total system compliance costs of new sources are summarized in Table 5-4[2/]. For the purpose of evaluating new source impacts, compliance costs of new source standards are defined as incremental costs over the costs of selected standards for existing sources. The selected treatment technology for existing sources is Treatment Option 2. The selected NSPS and PSNS technology is Option 2 plus filtration (this is equivalent to existing source Technology Option 3). As indicated in Table 5-4, the incremental annual compliance cost between Treatment Option 3 and Treatment Option 2 is less than 0.1 percent of plant revenues for all process subcategories. Incremental costs of such magnitude are not expected to result in barriers to entry.

[2/] Compliance cost estimates were based on aluminum forming normal plants developed by EPA. Section 8 of the development document explains in detail the composition of the normal plants.

7. SMALL BUSINESS ANALYSIS

The Regulatory Flexibility Act (RFA) of 1980 (P.L. 96-354), which amends the Administrative Procedures Act, requires Federal regulatory agencies to consider "small entities" throughout the regulatory process. The RFA requires an initial screening analysis to be performed to determine if a substantial number of small entities will be significantly impacted. If so, regulatory alternatives that eliminate or mitigate the impacts must be considered. This analysis addresses these objectives by identifying and evaluating the economic impacts of the aforementioned regulations on small aluminum forming plants. As described in Chapter 2, the small business analysis is developed as an integral part of the general economic impact analysis and is based on the examination of the distribution by plant size of the number of aluminum forming plants, plant revenues, wastewater volumes, compliance costs and potential closures from the regulations.

As explained in Section 2.11, rather than define small business in terms of firm total employment (i.e., SBA definition), a more appropriate definition for the present analysis is in terms of plant size, with size measured by rate of production. Several plant size definitions based on plant annual production are used to provide the EPA possible alternative definitions of small aluminum forming plants. These are:

- Plants with less than 200,000 pounds in production
- Plants with less than 500,000 pounds in production
- Plants with less than 1 million pounds in production
- Plants with less than 3 million pounds in production
- Plants with less than 5 million pounds in production
- Plants with less than 7 million pounds in production
- Plants with less than 10 million pounds in production
- Plants with less than 15 million pounds in production

Table 7-1 shows the number of aluminum forming plants falling into selected size categories as well as the potential plant closures due to regulations.

TABLE 7-1

DISTRIBUTION OF ALUMINUM FORMING PLANTS BY PRODUCTION VOLUME

	Total Number of Sample Plants	Number of Plants with Production (in million pounds)				
		<1	1-3	3-5	5-10	>10
Sheet and Plate - Total	21	1	2	1	1	16
Dischargers	12	0	2	1	0	9
Zero Dischargers	9	1	0	0	1	7
Potential Closures	0	0	0	0	0	0
Foil - Total	6	0	2	1	0	3
Dischargers	0	0	0	0	0	0
Zero Dischargers	6	0	2	1	0	3
Potential Closures	0	0	0	0	0	0
Tube and Extruded Shapes - Total	150*	9	16	14	40	64
Dischargers	74	1	3	7	15	48
Zero Dischargers	76*	8	13	7	25	16
Potential Closures	3	0	1	0	0	2
Conductor Wire and Cable - Total	44	14	3	4	7	5
Dischargers	9	1	1	1	4	2
Zero Dischargers	35	13	2	3	3	3
Potential Closures	1	0	0	0	1	0
SFE - Total	20	0	0	1	0	19
Dischargers	12	0	0	0	0	12
Zero Dischargers	8	0	0	1	0	7
Potential Closures	0	0	0	0	0	0
RBW - Total	6	1	0	0	0	5
Dischargers	5	0	0	0	0	5
Zero Dischargers	1	1	0	0	0	0
Potential Closures	0	0	0	0	0	0
Forging - Total	16	8	1	1	2	4
Dischargers	12	6	0	0	2	4
Zero Dischargers	4	2	1	1	0	0
Potential Closures	1	1	0	0	0	0
Total Industry	263	35	25	20	53	105
Dischargers	124	10	7	8	15	64
Zero Dischargers	139	25	18	12	38	41
Potential Closures	5	1	1	0	1	2

*Production data is not available for 7 plants.

Source: JRB Associates estimates.

A total of five plants (3 extrusion, 1 wire and 1 forging) are projected to close at all treatment options if all dischargers are required to comply with the effluent regulations. The forging plant projected to close is a small plant with less than 500,000 pounds annual production, and the wiredrawing closure has less than 6 million pounds of production. Meanwhile, the extrusion closures are not limited to small plants as they include 2 plants with annual production over 10 million pounds.

Tables 7-2 through 7-4 present the distribution of plant production and compliance costs by plant size for the three product groups in the potential plant closures as a result of regulation: extruded shapes, wire, and forging product groups, respectively.

TABLE 7-2

SUMMARY OF SMALL BUSINESS ANALYSIS - TUBE AND EXTRUDED SHAPES PRODUCT GROUP

	Total Sample Plants[a/]	Plants with Annual Production (in million lbs)				
		<3	3-5	5-10	10-15	>15
All Plants						
Number of Plants	150[a/]	25	14	40	20	44
Production-10^6 x lbs						
All Plants	2,101.8	37.5	52.8	287.3	235.5	1,488.7
Discharging Plants	1,528.8	5.4	25.9	105.1	131.9	1,260.5
Revenues-$millions	2,012.9	55.3	55.1	315.0	222.0	1,363.9
Direct Dischargers						
Number of Plants	34	1	2	4	4	23
Production-10^6 x lbs	969.8	b/	7.7	30.4	48.8	882.9
-% of disch.[c/]	63.4	b/	0.5	2.0	3.2	57.8
Potential Closures (All Options)						
Number	2	1	0	0	1	0
Employment	b/	b/	0	0	b/	0
Production-10^6lb	b/	b/	0	0	b/	0
Treatment Option 1						
Investment-$000	11,112.3	b/	203.6	643.4	519.1	9,746.2
Annual -$000	6,134.6	b/	142.4	314.3	1,029.5	4,648.4
-¢/1b	0.6	b/	1.8	1.0	2.1	0.5
Treatment Option 2						
Investment-$000	12,531.1	b/	168.9	138.3	749.3	10,874.6
Annual -$000	6,778.0	b/	166.4	383.1	1,096.6	5,131.9
-¢/1b	0.7	b/	2.2	1.3	2.2	0.6
Treatment Option 3						
Investment-$000	13,880.9	b/	200.6	803.5	862.6	12,014.2
Annual -$000	7,229.0	b/	177.5	402.6	1,150.1	5,498.8
-¢/1b	0.7	b/	2.3	1.3	2.4	0.6

TABLE 7-2

SUMMARY OF SMALL BUSINESS ANALYSIS - TUBE AND EXTRUDED SHAPES PRODUCT GROUP (Continued)

	Total Sample Plants[a]	Plants with Annual Production (in million lbs)				
		<3	3-5	5-10	10-15	>15
Indirect Dischargers						
Number of Plants	40	3	5	11	7	14
Production-10^6 x lbs	558.9	4.2	19.4	74.7	83.0	377.6
-% of disch.[c]	36.6	0.3	1.3	4.9	5.4	24.7
Potential Closures (All Options)						
Number	1	0	0	0	1	0
Employment	[b]	0	0	0	[b]	0
Production-10^6 x lbs	[b]	0	0	0	[b]	0
Treatment Option 1						
Investment -$000	7,563.5	49.0	620.6	1,346.8	913.8	4,633.3
Annual -$000	5,994.4	50.5	453.0	1,272.2	1,373.4	2,845.3
-¢/lb	1.1	1.2	2.3	1.7	1.7	0.8
Treatment Option 2						
Investment -$000	8,711.7	79.4	746.8	1,286.6	1,006.7	5,592.2
Annual -$000	6,725.6	58.5	495.0	1,356.1	1,427.7	3,388.3
-¢/lb	1.2	1.4	2.6	1.8	1.7	0.9
Treatment Option 3						
Investment -$000	9,590.8	84.6	816.2	1,477.7	1,133.6	6,078.7
Annual -$000	7,049.2	61.3	520.1	1,428.2	1,485.3	3,554.3
-¢/lb	1.3	1.5	2.7	1.9	1.8	0.9

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[a] Production data not available for 7 zero dischargers.

[b] Withheld to avoid disclosure of confidential data. Values are reported in the next size category.

[c] Percent of discharging plants.

[e] Estimated.

Source: JRB Associates estimates.

TABLE 7-3

SUMMARY OF SMALL BUSINESS ANALYSIS - CONDUCTOR WIRE AND CABLE PRODUCT GROUP

	Total Sample Plants[a]	Plants with Annual Production (in million lbs)				
		<3	3-5	5-7	7-10	>10
Number of Plants	44	23	5	3	5	8
Production-10^6 x lbs						
All Plants	376.9	11.1	20.1	17.1	40.4	288.2
Discharging Plants	117.5	1.0	4.2	17.1	8.3	b/
Revenues - $ millions		45.3	30.7	16.9	46.4	268.9
Direct Dischargers						
Number of Plants	1	0	0	0	0	1
Production 10^6 x lbs	b/	-	-	-	-	b/
-% of disch.[c]	b/	-	-	-	-	b/
Potential Closures (All Options)						
Number	0	-	-	-	-	0
Employment	0	-	-	-	-	0
Production-10^6 x lbs	0	-	-	-	-	0
Treatment Option 1						
Investment - $000	263.5	-	-	-	-	263.5
Annual - $000	114.8	-	-	-	-	114.8
-¢/1b	b/	-	-	-	-	b/
Treatment Option 2						
Investment - $000	263.5	-	-	-	-	263.5
Annual - $000	114.8	-	-	-	-	114.8
-¢/1b	b/	-	-	-	-	b/
Treatment Option 3						
Investment - $000	295.2	-	-	-	-	295.2
Annual - $000	123.9	-	-	-	-	123.9
-¢/1b	b/	-	-	-	-	b/

TABLE 7-3

SUMMARY OF SMALL BUSINESS ANALYSIS -
CONDUCTOR WIRE AND CABLE PRODUCT GROUP (Continued)

	Total Sample Plants[a]	Plants with Annual Production (in million lbs)				
		<3	3-5	5-7	7-10	>10
Indirect Dischargers						
Number of Plants	8	2	1	3	1	1
Production-10^6 x lbs	b/	1.0	b/	21.2	b/	21.3
-% of disch.[c]	b/	0.4	b/	18.0	b/	18.1
Potential Closures (All Options)						
Number	1	0	0	1	0	0
Employment	b/	0	0	b/	0	0
Production-10^6 x lbs	b/	0	0	b/	0	0
Treatment Option 1						
Investment - $000	1,121.3	9.7	23.1	215.9	333.3	539.3
Annual - $000	634.6	11.0	53.2	196.3	139.6	234.5
-¢/lb	b/	1.1	b/	1.2	b/	1.8
Treatment Option 2						
Investment - $000	1,121.3	9.7	23.1	215.9	333.3	539.3
Annual - $000	634.6	11.0	53.2	196.3	139.6	234.5
-¢/lb	b/	1.1	b/	1.2	b/	1.8
Treatment Option 3						
Investment - $000	1,233.3	9.7	23.1	261.3	365.0	574.1
Annual - $000	668.1	11.0	53.2	210.9	148.7	244.3
-¢/lb	b/	1.1	b/	1.2	b/	1.8

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[a] May not add up due to rounding errors.

[b] Withheld to avoid disclosure of confidential data. Values are reported in the next size category

[c] Percent of discharging plants

Source: JRB Associates estimates.

TABLE 7-4

SUMMARY OF SMALL BUSINESS ANALYSIS - FORGING PRODUCT GROUP

	Total Sample Plants[a]	Plants with Annual Production (in million lbs)					
		<.2	.2-.5	.5-1	1-3	3-5	>5
Number of Plants	16	4	4	0	2	0	6
Production-10^6 x lbs							
All Plants	99.1	0.3	1.2	0	3.9	0	93.7
Discharging Plants	95.1	0.3	1.0	0	0	0	93.7
Revenues - $ millions	281.0	1.3	16.7	0	7.7	0	256.1
Indirect Dischargers							
Number of Plants	12	2	4	0	0	0	6
Production 10^6 x lbs	95.1	0.1	1.2	-	-	-	93.7
-% of disch.[c]	100.0	0.1	1.3	-	-	-	98.5
Potential Closures (All Options)							
Number	1	1	0	0	0	-	0
Employment	[b]	[b]	0	0	0	-	0
Production-10^6 x lbs	[b]	[b]	0	0	0	-	0
Treatment Option 1							
Investment - $000	4,321.6	29.7	511.1	-	-	-	3,780.9
Annual - $000	2,043.3	32.1	265.7	-	-	-	1,745.4
-¢/lb	2.1	22.3	22.1	-	-	-	1.9
Treatment Option 2							
Investment - $000	4,543.4	52.5	599.9	-	-	-	3,891.0
Annual - $000	2,105.6	39.2	288.5	-	-	-	1,777.9
-¢/lb	2.2	27.2	24.0	-	-	-	1.9
Treatment Option 3							
Investment - $000	4,962.1	61.0	663.3	-	-	-	4,237.8
Annual - $000	2,218.0	42.2	306.6	-	-	-	1,869.2
-¢/lb	2.3	29.3	25.6	-	-	-	2.0

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[a] May not add up due to rounding errors.

[b] Withheld to avoid disclosure of confidential data.

[c] Percent of discharging plants.

Source: JRB Associates estimates.

8. LIMITATIONS OF THE ANALYSIS

This section discusses the major limitations of the economic impact analysis. It focuses on the limitations of the data, methodology, assumptions, and estimations made in this report.

8.1 DATA LIMITATIONS

The accuracy of the conclusions of this report depends largely on the accuracy of the data used in the analyses, especially that of the estimated compliance costs, and plant financial and economic characteristics.

A critical data input to this study is the compliance cost estimates. The assumptions relating to the estimation of compliance costs are outlined in the technical Development Document and summarized in Section 5.3 of this report. Total plant compliance costs were estimated for the multiple product plants. In order to estimate the price increases for each product group, the plant compliance costs were allocated to each product proportionately to production.

In the absence of a detailed financial survey for the aluminum forming industry, a financial profile of the aluminum forming industry was developed based on extensive review of trade literature and published financial reports. This financial profile is subject to the following major assumptions and limitations:

- Plant value of shipments were surveyed by EPA, however, there were missing data for a few plants. Thus, based on plant output volume reported in the EPA survey, plant revenues were estimated for these plants using 1977 prices published in the Bureau of Labor Statistics Producer Prices and Price Indexes.
- Lacking plant specific operating ratios such as profit margin, assets value, fixed and variable costs of production, industry average estimates were applied to the plants. The methodology for estimating these financial variables are explained in Appendix C.

- Only a single year's plant production and value of shipments data (1977) were collected in the EPA industry survey. Multiple years production data would have enabled a more in-depth analysis, encompassing the cyclical nature of the industry. As shown in Figure 3-3 in Chapter 3, the 1977 period was neither a peak nor a trough for the industry and the general economy and is, therefore, considered to be representative of average conditions in the industry over the long run.

8.2. METHODOLOGY LIMITATIONS

In addition to the data limitations described above, this study is also subject to limitations of the methodology used. These limitations are related to critical assumptions on price increase, profit impact, and capital availability analyses.

8.2.1 Price Increase Assumptions

Because the aluminum forming industry exhibits characteristics of both competitive and non-competitive market behavior, it is assumed that the industry's pricing behavior will follow a strategy that will maintain the industry-wide initial return on sales. This assumption appears to be fairly reasonable since the demand price elasticities for aluminum forming products are relatively inelastic.

8.2.2 Profit Impact Assumptions

In studies where detailed, plant-specific data are available, potential plant closures can be identified by using discounted cash flow analyses. Using this approach, a judgment can be made about the ability of a plant to continue in business after compliance with effluent regulations, by comparing the discounted value of the plant's cash flow with the plant's estimated salvage value. The application of this approach requires plant-specific data on cash flows and salvage values, and since data at this level of specificity were not available for this study, this approach was not deemed to be practical. As an alternative method, profitability impacts were measured through the use of return on investment (assets) analysis. Although this financial ratio analysis is based upon accounting data and do not account for the time value of money, it is widely used in comparative financial analyses and is simple to apply.

Another limitation relates to the ability of the profit impact methodology to assess the combined effects of the business cycle and the timing of the effective date of the regulation. As previously mentioned, portions of the study rely on inferences from only one or a few years of data. Where this occurred, care was taken to insure that any point estimate was not taken for an extreme year, such as a trough of a recession or a peak of an expansion. As shown in Figure 3-3, the 1977 time period was neither a peak nor a trough for the industry or the general economy; and is, therefore, considered to be representative of average conditions in the industry over a long period of time. Moreover, a recent EPA study on macroeconomic conditions projected that the aluminum forming industry will have recovered from the latest recession by 1985.[1] This study also forecasted that profit of the aluminum industry will return to the 1978-1979 level which is better than 1977. Therefore, the assumptions of 1977 profit level for this study seems to be conservative.

Finally, long term profitability estimates were used to project closures since major investment decisions are made primarily on the basis of long run expectations. Economic analysis generally distinguishes between long run and short run outcomes. Decisions regarding variable costs and relatively small amounts of resources are generally made on short run criteria. On the other hand, decisions regarding large investment in fixed assets are made on the basis of long run expectations. This means that large capital expenditures are generally made based on the expected return on the investment over a period of years. Cyclical fluctuations in the general economic conditions usually do not affect the outcome of these decisions but only their timing.

8.2.3 Capital Availability Assumptions

The capital investment requirements analysis was assessed through an evaluation of the "fixed charge coverage" ratio. Although this technique does not provide a precise conclusion on a firm's ability to make the investment, it does provide a good indication of the relative burden of the requirement.

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[1] USEPA, *Macroeconomic Conditions and Performance of Regulated Industries*, June 1983.

8.3 SENSITIVITY ANALYSES

The study's conclusions, as presented in Chapter 6, are based on the best estimates for key variables such as baseline profit and compliance cost estimates. To assess the sensitivity of the study's results to these parameters, sensitivity analyses were performed on the following factors:

- Industry baseline profit
- Monitoring costs
- Sludge disposal costs
- RCRA costs.

The sections below assess the effect of a change in these assumptions.

8.3.1 Sensitivity on Baseline Profit

As indicated in Appendix C, the aluminum forming industry baseline profit estimates are based on FTC line of business operating margin data for industry category 33.09 (aluminum sheet, plate and foil; aluminum estimated; aluminum rolling and drawing, nec). However, aluminum forming operation of integrated firms may be reported in industry category 33.06 (primary aluminum) because FTC allows the nonferrous metal companies to report their rolling and drawing activities together with their primary metal operations. As shown in Table C-2, the operating margin of industry group 33.06 is lower than industry group 33.09.

To evaluate the effects of a lower baseline profit for the integrated producers, a sensitivity analysis is performed assuming a 6.4 percent baseline return of assets (i.e., average of industry group 33.06 and 33.09) instead of 7.9 percent assumed in the analysis described in Chapter 6. The results of this sensitivity analysis show no additional plant closures.

8.3.2 Sensitivity Analysis on Monitoring Costs

Compliance costs used in the impact analysis presented in Chapter 6 assume monitoring schedule that vary from once a month to ten times a month depending on individual plant flow rate. A sensitivity analysis is performed to evaluate the effects of the maximum sampling of 10 tests a month on all plants. No additional closure is found under this monitoring schedule.

8.3.3 Sensitivity Analysis on Sludge Disposal Costs

In response to public comments that EPA underestimated the costs of sludge disposal, a sensitivity analysis is performed by doubling sludge disposal costs assumed in the analysis presented in Chapter 6. The results of this sensitivity analysis show that there will be additional closures of six plants at Treatment Option 2.

8.3.4 Sensitivity Analysis on RCRA Costs

The compliance cost estimates used in the impact analysis presented in Chapter 6 do not include costs associated with RCRA requirements for hazardous wastes disposal. EPA identified the presence of cyanide in the sludge of 11 forging plants and 8 drawing with neat oil plants. These plants will have to comply with RCRA requirements. EPA compliance cost estimates used in the analysis presented in Chapter 6 include the cost of sludge disposal. The additional cost of RCRA requirements over and above the sludge disposal costs were estimated to be (in 1982 dollars) $80,898 for all forging plants and $202,300 for all drawing with neat oil plants. Based on the above RCRA cost estimates, a sensitivity analysis is performed and the results show no additional closures due to RCRA requirements.

8.4 SUMMARY OF LIMITATIONS

Although the above factors may affect the quantitative accuracy of the impact assessments on specific aluminum forming plant, it is believed that the results of this study represent a valid industry-wide assessment of the economic impacts likely to be associated with effluent guideline control costs.

APPENDIX A

SELECTED FINANCIAL RATIOS

TABLE A-1
SELECTED FINANCIAL RATIOS FOR SHEET AND PLATE COMPANIES

SHEET AND PLATE	PROFITS/EQUITY			DEBT/EQUITY			PROFITS/SALES		
	1978	1977	1976	1978	1977	1976	1978	1977	1976
1) ALCAN ALUMINUM CORP.	30.1	23.6	7.6	41.3	52.5	65.9	14.0	11.7	3.8
2) ALUMINUM CO. OF AMERICA	23.7	15.8	13.0	53.5	62.9	68.6	12.4	8.6	7.5
3) ANACONDA CO./ARCO	25.4	19.6	25.6	47.8	54.9	52.8	11.0	8.5	11.7
4) RJR ARCHER, INC./RJ REYNOLDS CO.	32.1	33.0	32.7	27.8	31.8	31.3	12.9	12.4	12.0
5) ALUMAX, INC.	24.8	22.3	19.0	29.0	22.8	19.2	13.2	11.8	10.9
6) KAISER ALUMINUM & CHEMICAL CORP.	22.5	17.5	11.4	75.2	77.9	86.1	9.3	7.3	0.5
7) MARTIN MARIETTA ALUMINUM/ MARTIN MARIETTA CORP	28.0	26.3	20.3	17.4	30.2	38.4	13.8	13.2	11.0
8) MIRRO ALUMINUM CO.	8.0	13.7	11.1	31.6	33.8	35.0	2.7	5.1	4.4
9) NATIONAL ALUMINUM/ NATIONAL STEEL CORP.	15.7	6.5	9.6	46.5	50.3	52.3	5.6	2.6	4.2
10) REVERE COPPER & BRASS CO.	28.5	10.9	1.7	168.2	121.6	172.0	5.6	2.8	0.5
11) REYNOLDS METALS CO.	21.4	12.9	10.9	82.4	86.1	99.9	8.2	5.4	4.6
12) HUNTER DOUGLAS, INC.	18.1	14.9		57.2	66.9		4.5	4.3	
13) EKCO PRODUCTS INC./ AMERICAN HOME PRODUCTS INC.	57.0	56.6	54.1	0	0	0	21.9	21.9	21.7
14) HOWMET ALUMINUM CORP./ PECHINEY-UGINE KUHLMAN		11.4	6.2	0	0	0		3.2	1.8
15) CONSOLIDATED ALUMINUM CORP./ SWISS ALUMINUM LTD.		6.0	3.3		106.7	114.6		2.8	1.7
ALL MANUFACTURING	24.5	23.2	22.7	32.5	32.7	32.3	8.9	8.7	8.7

TABLE A-2
SELECTED FINANCIAL RATIOS FOR FOIL COMPANIES

FOIL	PROFITS/EQUITY			DEBT/EQUITY			PROFITS/SALES		
	1978	1977	1976	1978	1977	1976	1978	1977	1976
1) ALCAN ALUMINUM CORP.	30.1	23.6	7.6	41.3	52.5	65.9	14.0	11.7	3.8
2) ALUMINUM CO. OF AMERICA	23.7	15.8	13.0	53.5	62.9	68.6	12.4	8.6	7.5
3) ANACONDA CO. / DIV. ARCO	25.4	19.6	25.6	47.8	54.9	52.8	11.0	8.5	11.7
4) RJR ARCHER, INC./ RJ REYNOLDS CO.	32.1	33.0	32.7	27.8	31.8	31.3	12.9	12.4	12.0
5) ALUMAX, INC.	24.8	22.3	19.0	29.0	22.8	19.2	13.2	11.8	10.9
6) KAISER ALUMINUM & CHEMICAL CORP.	22.5	17.5	11.4	75.2	77.9	86.1	9.3	7.3	0.5
7) NATIONAL ALUMINUM / NATIONAL STEEL CORP.	15.7	6.5	9.6	46.5	50.3	52.3	5.6	2.6	4.2
8) REVERE COPPER & BRASS CO.	28.5	10.9	1.7	168.2	121.6	172.0	5.6	2.8	0.5
9) EKCO PRODUCTS, INC. / AM HOME PRODUCTS, INC.	57.0	56.6	54.1	0.0	0.0	0.0	21.9	21.9	21.7
10) CROWN CORK & SEAL CO.	27.5	28.3	28.3	3.3	3.5	8.2	9.2	9.8	9.9
11) GENERAL ELECTRIC CO.	32.7	31.8	31.0	15.1	21.6	25.2	11.0	10.8	10.4
12) HOWMET-ALUMINUM CORP./ PECHINEY-UGINE KUHLMAN		11.4	6.2		0	0		3.2	1.8
13) CONSOLIDATED ALUMINUM CORP./ SWISS ALUMINUM LTD		6.0	3.3		106.7	114.6		2.8	1.7

TABLE A-3
SELECTED FINANCIAL RATIOS FOR TUBE AND EXTRUDED SHAPES COMPANIES

TUBE AND EXTRUDED SHAPES	PROFITS/EQUITY			DEBT/EQUITY			PROFITS/SALES		
	1978	1977	1976	1978	1977	1976	1978	1977	1976
1) ALCAN ALUMINUM CORP.	30.1	23.6	7.6	41.3	52.5	65.9	14.0	11.7	3.8
2) ALUMINUM CO. OF AMERICA	23.7	15.8	13.0	53.5	62.9	68.6	12.4	8.6	7.5
3) ANACONDA CO./ DIV. OF ARCO	25.4	19.6	25.6	47.8	54.9	52.8	11.0	8.5	11.7
4) ALUMAX, INC.	24.8	22.3	19.0	29.0	22.8	19.2	13.2	11.8	10.9
5) KAISER ALUMINUM & CHEMICAL CORP.	22.5	17.5	11.4	75.2	77.9	86.1	9.3	7.3	0.5
6) MARTIN MARIETTA ALUMINUM / MARTIN MARIETTA CORP.	28.0	26.3	20.3	17.4	30.2	38.4	13.8	13.2	11.0
7) NATIONAL ALUMINUM / NATIONAL STEEL CORP.	15.7	6.5	9.6	46.5	50.3	52.3	5.6	2.6	4.2
8) REVERE COPPER & BRASS CO.	28.5	10.9	1.7	168.2	121.6	172.0	5.6	2.8	0.5
9) REYNOLDS METALS CO.	21.4	12.9	10.9	82.4	86.1	99.9	8.2	5.4	4.6
10) HOWMET ALUMINUM CORP./ PECHINEY-UGINE KUHLMAN		11.4	6.2					3.2	1.8
11) duPONT DE NEMOURS	28.2	22.7	20.4	22.2	28.6	31.8	12.7	10.4	9.8
12) EASCO CORP.	24.7	27.0	29.9	52.7	68.6	49.8	5.8	5.8	6.8
13) ELIXIR INDUSTRIES	22.9	27.7	22.1	44.0	35.4	25.3	5.2	6.2	5.6
14) ENVIRONMENTAL ELEMENTS CORP./ KOPPER CO.	24.8	24.1	25.4	42.6	29.3	33.7	8.1	8.4	9.1
15) ESSEX INTERNATIONAL, INC./ UNITED TECHNOLOGIES, CORP.	27.9	28.4	27.2	20.4	23.8	35.7	7.9	7.5	6.6
16) ETHYL CORP.	26.8	27.4	27.2	41.0	48.0	54.9	11.0	11.3	11.4

TABLE A-3
SELECTED FINANCIAL RATIOS FOR TUBE AND EXTRUDED SHAPES COMPANIES (Continued)

TUBE AND EXTRUDED SHAPES	PROFITS/EQUITY			DEBT/EQUITY			PROFITS/SALES		
	1978	1977	1976	1978	1977	1976	1978	1977	1976
17) FRUEHAUF CORP.	28.6	23.9	20.4	84.1	80.0	85.8	6.3	5.9	5.6
18) GENERAL MOTORS CORP.	37.5	39.8	38.0	3.8	4.0	4.9	10.4	11.4	11.6
19) HEATH-TECNA CORP.	62.5	33.0	30.2	94.6	0	.7	9.0	7.8	7.5
20) INTERNATIONAL ALUMINUM CORP.	46.0	41.8	36.6	3.3	4.7	8.3	16.1	15.0	14.9
21) KELLER INDUSTRIES, INC.	23.0	20.4		52.1	29.3		7.7	7.1	
22) KINKEAD INDUSTRIES, INC./ U.S. GYPSUM CORP.	33.9	22.5	13.5	22.1	28.8	22.6	14.1	9.7	6.7
23) LEAR SIEGLER, INC.	38.9	35.5	25.2	58.8	79.1	46.5	8.6	8.4	6.9
24) LOUISIANA PACIFIC CORP.	23.3	26.8	18.5	34.0	56.6	70.4	12.5	12.1	10.3
25) MICHIGAN GENERAL CORP.	1.3	17.5	28.4	185.0	182.4	119.6	0.2	2.4	4.7
26) MIDEAST ALUMINUM INDUSTRIES/ INDAL LIMITED		30.1	35.5		43.0	52.1		8.4	11.3
27) NORANDA ALUMINUM, INC./ NORANDA MINES, LTD.	26.2	14.4		68.3	77.6		13.7	7.8	
28) PPG INDUSTRIES	20.5	18.4	26.6	43.5	47.4	50.7	8.5	7.8	12.0
29) REDMAN INDUSTRIES	36.9	34.5	3.0	68.7	127.0	237.2	4.5	3.7	0.2
30) ROBERTSON CO./ H.H.	22.5	18.1	23.9	39.9	13.5	17.2	4.9	5.5	6.9
31) RUSCO INDUSTRIES, INC.	7.8	17.1	7.9	58.9	70.2	119.3	1.1	2.3	0.9
32) SEAGRAVE CORP.	15.8	14.6		30.2	36.6		5.0	4.4	
33) WINNEBAGO INDUSTRIES	2.4	7.4					0.8	2.8	6.8
34) CONSOLIDATED ALUMINUM CORP./ SWISS ALUMINUM, LTD.		6.0	3.3		106.7	114.6		2.8	1.7

TABLE A-3
SELECTED FINANCIAL RATIOS FOR TUBE AND EXTRUDED SHAPES COMPANIES (Continued)

TUBE AND EXTRUDED SHAPES	PROFITS/EQUITY			DEBT/EQUITY			PROFITS/SALES		
	1978	1977	1976	1978	1977	1976	1978	1977	1976
35) ARVIN INDUSTRIEC, INC.	28.2	41.2	41.7	61.1	72.3	78.5	9.2	12.5	12.2
36) LA POINTE INDUSTRIES, INC.	30.1	17.3	9.2	2.9	2.1	0	8.7	10.3	4.4
37) GIFFORD-HILL & CO., INC.	24.0	17.1	16.1	40.5	47.6	43.5	9.5	6.8	6.5
38) JFD ELECTRONICS CORP./ UNIMAX GROUP, INC.	41.1	53.7		204.7	292.4		7.7	7.4	5.7

TABLE A-4
SELECTED FINANCIAL RATIOS FOR ROD AND BAR COMPANIES

ROD AND BAR	PROFITS/EQUITY			DEBT/EQUITY			PROFITS/SALES		
	1978	1977	1976	1978	1977	1976	1978	1977	1976
1) ALCAN ALUMINUM CORP.	30.1	23.6	7.6	41.3	52.5	65.9	14.0	11.7	3.8
2) ALUMINUM CO. OF AMERICA	23.7	15.8	13.0	53.5	62.9	68.6	12.4	8.6	7.5
3) ANACONDA CO./ DIV. OF ARCO	25.4	19.6	25.6	47.8	54.9	52.8	11.0	8.5	11.7
4) KAISER ALUMINUM & CHEMICAL CORP.	22.5	17.5	11.4	75.2	77.9	86.1	9.3	7.3	0.5
5) MARTIN MARIETTA ALUMINUM/ MARTIN MARIETTA CORP.	28.0	26.3	20.3	17.4	30.2	38.4	13.8	13.2	11.0
6) REYNOLDS METALS CO.	21.4	12.9	10.9	82.4	86.1	99.9	8.2	5.4	4.6
7) ESSEX INTERNATIONAL INC./ UNITED TECHNOLOGIES CORP	27.9	28.4	27.2	20.4	23.8	35.7	7.9	7.5	6.6
8) NORANDA ALUMINUM, INC./ NORANDA MINES LTD.	26.2	14.4		68.3	77.6		13.7	7.8	
9) CYPRUS MINES CORP.	17.8	5.2		66.7	76.4		30.3	-6.7	
10) CONSOLIDATED ALUMINUM CORP. AMERICAN ELECTRICAL INDUSTRIES/ SWISS ALUMINUM LTD		6.0	3.3		106.7	114.6		2.8	1.7

TABLE A-5
SELECTED FINANCIAL RATIOS FOR WIRE AND CABLE COMPANIES

WIRE AND CABLE	PROFITS/EQUITY			DEBT/EQUITY			PROFITS/SALES		
	1978	1977	1976	1978	1977	1976	1978	1977	1976
1) ALCAN ALUMINUM CORP.	30.1	23.6	7.6	41.3	52.5	65.9	14.0	11.7	3.8
2) ALUMINUM CO. OF AMERICA	23.7	15.8	13.0	53.5	62.9	68.6	12.4	8.6	7.5
3) ANACONDA CO. / DIV. OF ARCO	25.4	19.6	25.6	47.8	54.9	52.8	11.0	8.5	11.7
4) PHELPS DODGE CABLE & WIRE CO./ PHELPS DODGE CORP.	3.6	2.3	5.0	69.0	57.8	62.7	3.4	2.3	4.7
5) KAISER ALUMINUM & CHEMICAL CORP.	22.5	17.5	11.4	75.2	77.9	86.1	9.3	7.3	0.5
6) REYNOLDS METALS CO.	21.4	12.9	10.9	82.4	86.1	99.9	8.2	5.4	4.6
7) GENERAL ELECTRIC CO.	32.7	31.8	31.0	15.1	21.6	25.2	11.0	10.8	10.4
8) ESSEX INTERNATIONAL, INC./ UNITED TECHNOLOGIES, CORP.	27.9	28.4	27.2	20.4	23.8	35.7	7.9	7.5	6.6
9) GENERAL MOTORS CORP.	37.5	39.8	38.0	3.8	4.0	4.9	10.4	11.4	11.6
10) NORANDA ALUMINUM, INC./ NORANDA MINES LTD.	26.2	14.4		68.3	77.6		13.7	7.8	
11) CYPRUS MINES CORP.	17.8	5.2		66.7	76.4	67.5	30.3	-6.7	
12) CONTINENTAL COPPER & STEEL	5.5	3.8	-3.0	87.6	96.7	83.5	1.4	1.3	-12.4
13) COPPERWELD CORP.	13.9	17.7	27.4	41.3	43.4	42.6	4.5	6.6	11.1
14) WESTINGHOUSE ELECTRIC CORP.	19.2	18.6	16.9	15.2	17.8	23.4	7.0	7.0	5.9

TABLE A-~~7~~6. SELECTED FINANCIAL RATIOS FOR FORGING COMPANIES

FORGINGS	PROFITS/EQUITY			DEBT/EQUITY			PROFITS/SALES		
	1978	1977	1976	1978	1977	1976	1978	1977	1976
1) ANACONDA CO./ARCO	25.4	19.6	25.6	47.8	54.9	52.8	11.0	8.5	11.7
2) EASCO CORP.	24.7	27.0	29.9	52.7	68.6	49.8	5.8	5.8	6.8
3) KAISER ALUMINUM & CHEMICAL CORP.	22.5	17.5	11.4	75.2	77.9	86.1	9.3	7.3	0.5
4) MARTIN MARIETTA ALUMINUM/MARTIN MARIETTA CORP.	28.0	26.3	20.3	17.4	30.2	38.4	13.8	13.2	11.0
5) REVERE COPPER & BRASS CO.	28.5	10.9	1.7	168.2	121.6	172.0	5.6	2.8	0.5
6) TRW INC.	31.6	31.6	28.9	41.8	43.3	45.3	8.6	9.0	8.2
7) WHITTAKER CORP.	32.2	17.7	17.1	72.9	83.6	111.5	7.0	4.0	3.8
ALL MANUFACTURING	24.5	23.2	22.7	32.5	32.7	32.3	8.9	8.7	8.7

APPENDIX B

CALCULATION OF PROFIT IMPACT THRESHOLD VALUE

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CALCULATION OF PROFIT IMPACT THRESHOLD VALUE

The evaluation of the economic viability of a plant after compliance to the regulations is based on determining whether it is more profitable for the stockholders to keep the plant in operation or to liquidate the plant and invest the proceeds in alternative investments. To answer this question, it is necessary to calculate the plant after-tax return on liquidation value of stockholders' equity and compare it to the opportunity cost of other investment alternatives. As illustrated in the following example, a plant is earning 5 percent after-tax return on the book value of equity; however, assuming the liquidation value of assets is 75 percent of book value, the return on liquidation value of equity would be 10 percent. If the alternative investments yield 8 percent, it would be better for the stockholders to keep the plant in operation.

	Book Value	Liquidation Value
Assets ($ million)	10.0	7.5
Debt ($ million)	5.0	5.0
Equity ($ million)	5.0	2.5
Before-tax profit ($ million)	0.5	0.5
After-tax profit ($ million)	0.25	0.25
After-tax return on equity (%)	5.0	10.0

The above illustration shows that after-tax return on liquidation value of equity would vary when the assumptions on liquidation value, capital structure (i.e., debt to equity ratio), and corporate income tax rate change. To avoid recalculating after-tax return on liquidation value of equity every time any of the above assumptions is changed, the analysis is modified to use before-tax return on book value of assets (which is not affected by any of the above mentioned assumptions) to evaluate the plant's profitability. This modified analysis requires that the opportunity cost of alternative investments expressed in terms of required after-tax return on equity investment be translated into a targeted before-tax rate of return on book value of assets. The next section describes how the threshold value of book value return on assets is derived. The section that follows explains the estimation of the opportunity cost of investment.

B.1 ESTIMATION OF BEFORE-TAX RETURN ON BOOK VALUE OF ASSETS THRESHOLD VALUE

To translate the targeted after-tax return on book value of equity into a before-tax return on book value of assets the following steps are proceeded. First, the ratio of liquidation value of equity to assets is expressed in terms of the equity to assets ratio and is:

$$LE = LA - LD$$

$$LD = D$$

$$LE = LA - D$$

$$= LA - (A - E)$$

$$\frac{LE}{A} = \frac{LA - (A - E)}{A} = \frac{LA}{A} - (1 - \frac{E}{A})$$

where:

A = book value of assets

LA = liquidation value of assets

D = book value of debt

LD = liquidation value of debt (assumed to be equal to D)

E = book value of equity

LE = liquidation value of equity.

For example, if the liquidation value of assets is 75 percent of book value (i.e., $LA/A = 0.75$), and the book value equity to assets ratio (E/A) is 0.45, the ratio of liquidation value of equity to assets (LE/A) is:

$$\frac{LE}{A} = 0.75 - (1 - 0.45) = 0.20$$

That is, the liquidation value of equity is 20 percent of the book value of assets.

To calculate the rate of return on book value of assets (ROI) that will yield to the stockholders an after-tax return r on the liquidation value of their equity, the following algorithms are used:

$$ATROI = \frac{ATP}{A} = \frac{ATP}{LE} \times \frac{LE}{A} = r \times \frac{LE}{A}$$

$$BTROI = ATROI \div (1 - t)$$

where: ATROI = After-tax return on book value of assets
ATP = After-tax profit
BTROI = Before-tax return on book value of assets
t = Corporate tax rate

Assuming the required rate of return on liquidation value of equity r is 8 percent and the corporate tax rate is 40 percent,

$$ATROI = 8 \times 0.2 = 1.6 \text{ percent}$$
$$BTROI = 1.6 \div (1 - 0.4) = 2.67 \text{ percent.}$$

That is the profit impact threshold value is 2.67 percent of book value of assets.

Table B-1 presents estimates of the profit impact threshold values for selected assumptions on assets liquidation value ratio, equity to assets ratio, and corporate tax rate.

TABLE B-1. ESTIMATED ROI THRESHOLD VALUES THAT GENERATE 8% ROE

ATROE = 8.0 PERCENT

E/A	LA/A	LE/E	ATROI (%)	T = 40% BTROI (%)	T = 35% BTROI (%)
0.40	0.85	0.625	2.00	3.33	3.08
0.40	0.80	0.500	1.60	2.67	2.46
0.40	0.75	0.375	1.20	2.00	1.85
0.40	0.70	0.250	0.80	1.33	1.23
0.40	0.65	0.125	0.40	0.67	0.62
0.40	0.60	-.000	****	****	****
0.40	0.55	-.125	****	****	****
0.40	0.50	-.250	****	****	****
0.45	0.85	0.667	2.40	4.00	3.69
0.45	0.80	0.556	2.00	3.33	3.08
0.45	0.75	0.444	1.60	2.67	2.46
0.45	0.70	0.333	1.20	2.00	1.85
0.45	0.65	0.222	0.80	1.33	1.23
0.45	0.60	0.111	0.40	0.67	0.62
0.45	0.55	-.000	****	****	****
0.45	0.50	-.111	****	****	****
0.50	0.85	0.700	2.80	4.67	4.31
0.50	0.80	0.600	2.40	4.00	3.69
0.50	0.75	0.500	2.00	3.33	3.08
0.50	0.70	0.400	1.60	2.67	2.46
0.50	0.65	0.300	1.20	2.00	1.85
0.50	0.60	0.200	0.80	1.33	1.23
0.50	0.55	0.100	0.40	0.67	0.62
0.50	0.50	-.000	****	****	****

B.2 ESTIMATION OF OPPORTUNITY COST OF ALTERNATIVE INVESTMENT

As explained in Section 2.5, the opportunity cost of alternative investments is assumed to be equal to the rate of a risk-free investment (such as Treasury bonds) plus a risk-premium factor. For this study, the risk adjusted opportunity cost is assumed to be 8 percent after tax return on the liquidation value of stockholders' equity. The 8 percent targeted return on equity investment is based on a 6.7 percent risk-free rate for 3-year Treasury bonds for 1977 plus a 1.2 percent risk-premium factor. The year 1977 was selected for both the industry baseline profit and the cost of capital estimates because it was neither a cyclical peak year nor a cyclical trough year and therefore seemed to represent a normal year for both the aggregate economy and the aluminum industry.

The risk premium is defined as the average spread between returns on risk-free investments (such as 3-year U.S. Treasury bonds) and returns to equity investment in the aluminum industry. This spread is estimated as follows:

$$[r_{S\&P400} - r_{TB}] \times B_{al}$$

and

$$r_{S\&P400} = d_{S\&P400} + dP_{S\&P400}$$

where

$r_{S\&P400}$ = rate of return on equity for the Standard and Poors 400 industrial stocks

r_{TB} = yield on 3-year U.S. Treasury bonds

B_{al} = beta coefficient (a measure of variability of financial returns) for aluminum stocks

$d_{S\&P400}$ = annual dividend yield of the S&P 400 industrial stocks

$dP_{S\&P400}$ = annual change in price of the S&P 400 industrial stocks.

The 1960-1982 average spread between 3-year Treasury bond yields and S&P 400 industrial stocks returns is 1 percent. Assuming the beta factor for aluminum stocks is 1.2, the risk premium for aluminum stocks would be 1.2 percent.

APPENDIX C

ESTIMATION OF PLANT ASSETS VALUE AND BASELINE RETURN ON SALES

APPENDIX C

ESTIMATION OF PLANT ASSETS VALUE AND BASELINE RETURN ON SALES

This appendix described the methodology for estimating two critical financial parameters of the economic impact analysis. These parameters are:

- Plant assets value, and
- Plant baseline return on sales.

Data for the above estimations are obtained from the 1977 Census of Manufactures, the Federal Trade Commission's Annual Line of Business Report and Quarterly Financial Report for Manufacturing, Mining and Trade Corporations, and various corporate annual reports.

C.1 ESTIMATION OF PLANT ASSETS VALUE

For this analysis, plant assets is defined as plant property and equipment net of depreciation, plus inventories and other current assets (i.e., cash, short-term investments, receivables, etc.). Table C-1 presents the steps and assumptions for estimating aluminum forming plant assets values. The asset values range from 52 percent to 68 percent of annual value of shipments.

C.2 ESTIMATION OF BASELINE RETURN ON SALES

The industry baseline ROI estimate is based on FTC Line of Business data (LBD) which is the most readily available public information on disaggregated line-of-business financial performance. Operating margins (i.e., earnings before interest expenses and income taxes) are calculated from FTC LBR data for 1974-1976 and projected to 1977 which appears to be a cyclically normal year of moderate expansion for the aluminum industry and the aggregate economy and is, therefore considered to be representative of average conditions in the industry over the long run. The operating margins of industry category

TABLE C-1. ESTIMATION OF PLANT ASSETS VALUE

Product Group	GBVFA/VS[a] (1)	DEP/GBVFA[b] (2)	INV/VS[c] (3)	OCA/VS[d] (4)	ASSETS/VS[e] (5)
Sheet and Plate (SIC 3353)	.39	.40	.25	.20	.68
Foil (SIC 3353)	.39	.40	.25	.20	.68
Extruded Shapes (SIC 3354)	.29	.40	.16	.20	.53
Rod, Bar and Bare Wire (SIC 3355)	.23	.40	.18	.20	.52
Wire (SIC 3357)	.32	.40	.14	.20	.53
Forging (SIC 3463)	.35	.40	.25	.20	.66

[a] GBVFA/VS = 1977 average of beginning and end-of-year gross book value of fixed assets to value of shipments as reported by Census of Manufactures.

[b] Depreciation/GBVFA = accumulated assets depreciation to gross book value of fixed assets of Nonferrous Metals industry as reported in Federal Trade Commission's *Quarterly Financial Report*.

[c] INV/VS = 1977 average of beginning and end-of-year inventories to value of shipments as reported by Census of Manufactures.

[d] OCA/VS = 4th Quarter 1977 other current assets (i.e., total current assets less inventories) to sales of Nonferrous Metals Industry as reported in FTC's *Quarterly Financial Report*.

[e] Assets/VS = plant total assets to value of shipments = (1) x [1 - (2)] + (3) + (4).

SOURCE: JRB Associates estimates.

TABLE C-2. ESTIMATION OF ALUMINUM FORMING BASELINE OPERATING MARGIN

	OPERATING INCOME[a] (In Percent of Assets)			
YEAR	BIG-THREE[b]	LBR 33.06[c]	LBR 33.09[d]	AVERAGE OF 33.06 AND 33.09
1974	11.3	10.7	14.1	12.4
1975	6.4	3.2	4.1	3.7
1976	7.8	6.5	11.2	8.9
1974-76 Avg.	8.5	6.7	9.8	8.3
1977	9.1	7.3[e]	10.4[e]	8.9[e]

[a] Earnings before interest expenses and income taxes.

[b] Averages for Alcoa, Kaiser Aluminum, and Reynolds Metals.

[c] Federal Trade Commission's Line of Business Report, industry category 33.06 (primary aluminum).

[d] Federal Trade Commission's Line of Business Report, industry category 33.09 (aluminum sheet, plate, and foil; aluminum extruded products; aluminum rolling and drawing, nec).

[e] Estimated assuming 1977 spread between LBR and Big-Three operating income is equal to the average differential for 1974 to 1976.

SOURCE: JRB Associates estimates.

TABLE C-3. ESTIMATION OF RETURN ON SALES

PRODUCT GROUP	(1) BASELINE OPERATING INCOME TO ASSETS (%)	(2) INTEREST EXPENSES TO ASSETS[a] (%)	(3) BASELINE ROI[b] (%)	(4) ASSETS/VS[c]	(5) BASELINE ROS[d] (%)
Sheet and Plate (SIC 3353)	10.4	2.5	7.9	.68	5.4
Foil (SIC 3353)	10.4	2.5	7.9	.68	5.4
Extruded Shapes (SIC 3354)	10.4	2.5	7.9	.53	4.2
Rod, Bar and Bare Wire (SIC 3355)	10.4	2.5	7.9	.52	4.1
Wire (SIC 3357)	10.4	2.5	7.9	.53	4.2
Forging (SIC 3463)	10.4	2.5	7.9	.66	5.2

[a] 1977 average for Alcoa, Kaiser Aluminum, and Reynolds Metals.

[b] Equals (1) - (2).

[c] ASSETS/VS = plant assets to value of shipments as estimated in Table C-1.

[d] Equals (3) x (4).

SOURCE: JRB Associates estimates.

33.09 (aluminum sheet, plate and foil; aluminum extruded products; aluminum rolling and drawing, nec) are selected to represent the aluminum forming industry. Table C-2 presents the estimation of 1977 baseline operating margin of the aluminum forming industry, and Table C-3 described the calculation of the average baseline returns on sales of each aluminum forming product group.

The ROI estimate is applied to each of the six product groups in this study, even though the actual ROI calculated by individual firms may differ among product groups within a particular firm. There are reasons for using a single ROI for all product groups. First, the aluminum industry is highly integrated both horizontally and vertically. Economic theory indicates that rational multi-product firms will invest in the product line that provides the greatest marginal return. This implies that over the long run the returns to different lines of business will converge. Second, there is a lack of available profit data that correspond to the product line definitions used in this study. Third, many integrated firms consider it important to their marketing efforts to have a "full", well-rounded product line, even though some products may be less profitable than others. In this type of situation it is difficult to determine from accounting data the "true" profit attributable to a specific product group. The fourth reason for using a single profit rate involves variations in transfer pricing policies among firms. Because transfer pricing policies vary among firms and because transfer prices of any specific firm may differ from one type of financial report to another (i.e., Census versus annual report versus tax reporting), it is often difficult to estimate a range of values that is appropriate for an industry-wide assessment. For these reasons, the average profit rates from the FTC LBR appears to be a valid representation of baseline industry-wide profit rates.

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